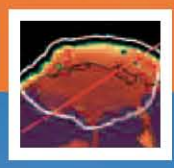
GTOS



Global Terrestrial Observing System

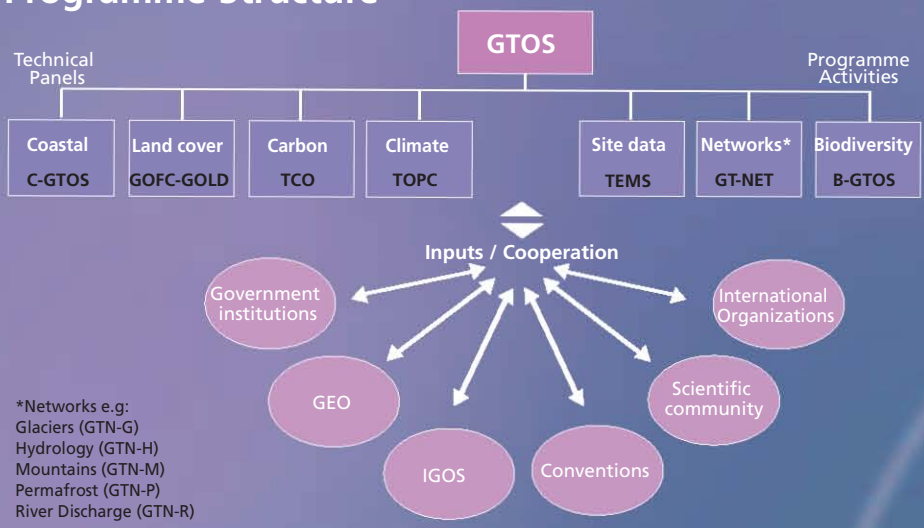
2004 – 2005

Biennial Report

COOPERAZIONE ITALIANA

WMO UNESCO UNEP ICSU FAO

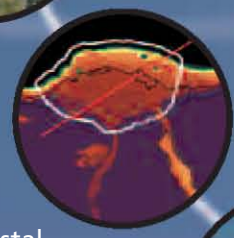
Programme Structure



*Networks e.g:
Glaciers (GTN-G)
Hydrology (GTN-H)
Mountains (GTN-M)
Permafrost (GTN-P)
River Discharge (GTN-R)

A global system for observations, modelling and analysis of terrestrial ecosystems to support sustainable development.

Mission: facilitate access to reliable information on terrestrial ecosystems so that researchers and policy-makers can detect and manage global and regional environmental change.



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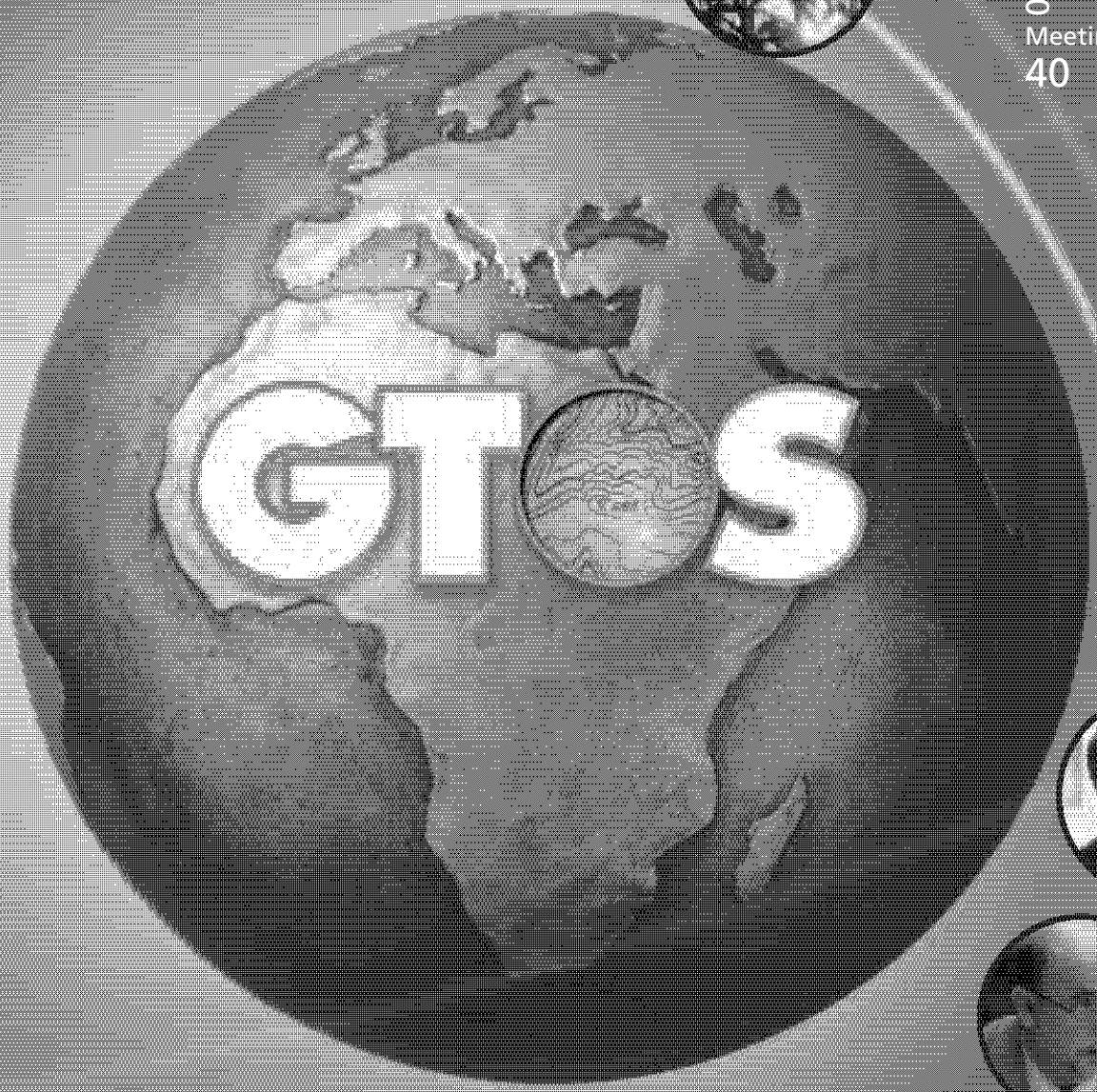
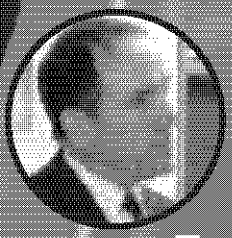
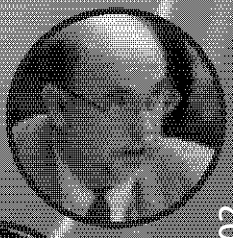
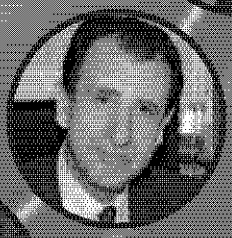
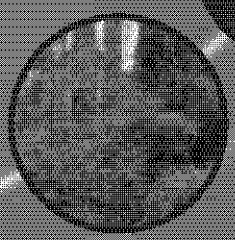
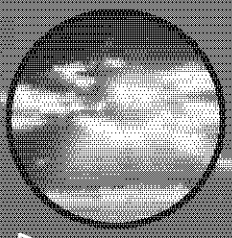


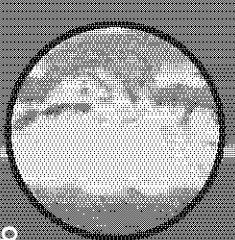


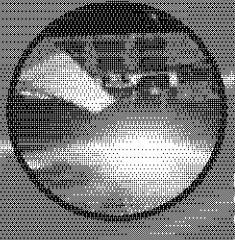


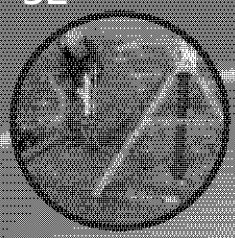


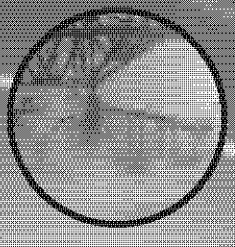












001

Berrien Moore

The evidence is now overwhelming that human activity has altered significantly the planet's environment at the regional, continental and planetary scales

Letter from the Chair

Since ancient times, humans have modified natural systems and thereby affected their local environment. However, since the beginning of the Industrial Revolution, human activity has changed the environment on larger and larger scales. The evidence is now overwhelming that human activity has altered significantly the planet's environment at the regional, continental and planetary scales.

- For the carbon cycle, the values of important state variables, such as the concentration of atmospheric carbon dioxide (CO_2) and methane (CH_4), are moving into a range without historical precedent in the last 25 million years: the atmospheric CO_2 concentration has increased by more than one-third since the beginning of the Industrial Revolution; CH_4 has doubled. The global annual flux of sulphur to the atmosphere has increased by more than half, and more nitrogen is now fixed synthetically and applied as fertilizers in agriculture than is fixed naturally in all terrestrial ecosystems.
- Nearly half of the land surface has been transformed by direct human action, with significant consequences for biodiversity, nutrient cycling, soil structure, soil biology and climate. More than one-fifth of terrestrial ecosystems have been converted into permanent croplands; more than one-quarter of the world's forests have been cleared; most temperate old-growth forest has been cut.
- Rain forests cover 7 percent of Earth's land surface, and 2 percent of the total surface, yet they are home to more than half of the world's plants and animals. At the current rate of clearing, the rainforests in effect will have disappeared within 100 years, extirpating most of these plant and animal species and affecting the global climate in unknown ways.
- Humankind uses more than half of all accessible freshwater directly or indirectly; our underground water resources are being depleted rapidly.
- Coastal habitats are being dramatically altered; half of all mangroves have been removed; wetlands have shrunk by one-half. Approximately 22 percent of recognized marine fisheries are either overexploited or already depleted, and 44 percent more are near their limit.
- Extinction rates are increasing sharply in marine and terrestrial ecosystems worldwide; the Earth is now in the midst of its first great extinction event caused by the activities of a single biological species: *Homo sapiens*.

Humans are altering the ecology of the planet; the chemistry of the planet; and the climate of the planet. Moreover, these changes are coupled in an exceedingly complex manner. Multiple, concurrent interactions among the biota, between the biota and their environment, and between the environment and our social institutions may produce unpredictable results, with cascading feedbacks.

However – and fortunately – global human society is confronting changes in the global environment through an expanding and strengthening set of international environmental conventions, the most notable being the highly successful Convention for the Protection of the Ozone Layer, and the UN Framework Convention on Climate Change (UNFCCC). Importantly – and, again, fortunately – there are other conventions addressing other critical environmental issues, including the UN Convention to Combat Desertification (UNCCD) and a set of biodiversity-related conventions, including the Convention on Biological Diversity (CBD), the Ramsar Convention on Wetlands, and the Convention on Migratory Species of Wild Animals (CMS).

Providing scientific information to the various subsidiary bodies of these conventions has become a guiding strategic initiative for GTOS. Consequently, throughout 2005, GTOS has strengthened its linkages with international conventions and

multilateral environmental agreements through awareness-raising initiatives. For this initiative, we have been fortunate to have received generous support from Italian Development Cooperation.

As I noted earlier, the planet and human society are jointly experiencing significant environmental change, and much of the change is in the wrong direction. There are shortages of clean and accessible freshwater; degradation of terrestrial and aquatic ecosystems; increases in soil erosion; loss of biodiversity; changes in the chemistry of the atmosphere; alterations in coastal zones; and the possibility of significant change in climate. These human-induced changes are over and above the pressures imposed by the natural variability of a dynamic planet, and are interacting with the effects of past and existing patterns of conflict, poverty, disease and malnutrition.

The changes are changes in the human–nature relationship. They are recent; they are profound; and many are accelerating. They cascade through the Earth's environment in ways that are difficult to understand and often impossible to predict. At the least, these human-driven changes in the global environment will require that societies develop a multitude of creative responses and adaptive strategies. The linked challenges of not only confronting and coping with global environmental changes but also addressing and securing a sustainable future are daunting and immediate, but they are not insurmountable. The challenges can be met, but only with a new and even more vigorous approach to understanding our changing planet, with a concomitant commitment by all to alter our actions. We simply must take some of the pressure off the Earth and its living communities.

We believe that the environmental conventions offer a constructive means of doing just that – taking some of the pressure off the Earth. GTOS is making a significant contribution to the success of these conventions, and we will continue to do so in the future. It is the right thing to do, and supporting the global environmental conventions will therefore be a strategic direction for GTOS.

There is another closely connected strategic theme where GTOS will focus its efforts, and that is the Global Earth Observing System of Systems (GEOSS). In July 2003, the [first] Earth Observation Summit (EOS) was hosted by the United States of America, in Washington, D.C. Thirty-three nations and the European Commission participated, and affirmed "the need for timely, quality, long-term, global information as a basis for sound decision making." They noted

> *"In order to monitor continuously the state of the Earth, to increase understanding of dynamic Earth processes, to enhance prediction of the Earth system, and to further implement our environmental treaty obligations, we recognize the need to support:*
> *(1) Improved coordination of strategies and systems for observations of the Earth and identification of measures to minimize data gaps, with a view to moving toward a comprehensive, coordinated, and sustained Earth observation system or systems;"*

In April 2004, the second EOS, in Tokyo, Japan, endorsed the GEOSS concept. At the third summit (Brussels, Belgium, February 2005) the participating governments accepted the draft 10-year plan to implement GEOSS.

Throughout this GEOSS process, GTOS has been working closely with the participants and has helped identify critical theses and actions. Given the synergy with the observational needs of the environmental conventions, and the broader connections with sustainable development and other essential needs for a better human society, GTOS will not only incorporate the observational needs of GEOSS in its strategic thinking but will also contribute to defining the direction of the GEOSS agenda. Again, we believe that this is the right thing to do.

The coming year will offer great challenge to GTOS, but in challenge there is also opportunity. We look forward to the challenges and opportunities to help meet needs in securing a more just and sustainable future for all.

002

John latham

GEOSS will provide the political support to develop a global coordinated monitoring effort

Biennial review from the Programme Director

Global need

The 2004–2005 biennium was a particularly busy period for GTOS and the international observations community as a whole. The increase in number and intensity of natural disasters, as well as the rise in reporting on the evidence and effects of climate change on local, regional and global systems, are cause for concern, motivating policy-makers to intensify national and international efforts to understand, prevent and adapt to climate change. Clearly, climate change is a real threat to development and puts additional pressure on already limited resources. The Global Earth Observation System of Systems (GEOSS) should ensure the needed political support; what is now required are the financial resources to develop a coordinated infrastructure for collecting, processing, analysing and distributing the observations needed by the broad user community.

GEOSS

Since its start in 2003, GEOSS has become the focal point and guidance for all institutions, initiatives and individuals involved in environmental observations. GTOS and its Panels have actively supported the process and have contributed to the development of the nine societal benefit areas and the ten-year implementation plan. GTOS remains committed to the process as an active participating agency implementing a number of critical tasks related to the societal benefit areas.

Land observations

An important collaborator in the GEOSS process has been the Integrated Global Observing Strategy (IGOS) Partnership, which has provided the expertise, knowledge and experience in Earth observations that have been fundamental in the development of GEOSS. GTOS has been an active partner of IGOS and supported the development of many of its themes (e.g. coastal and carbon). In the last biennium, it co-chaired the development of the land theme and assisted FAO in co-chairing the IGOS Partnership.

GTOS developments

A period of significant maturity, strategic development and output have characterized the activities of GTOS, its Panels and related initiatives. The Global Observation of Forest and Land Cover Dynamics (GOFC-GOLD) has revised its strategy, and has made significant progress in its land cover activities and its fire mapping and monitoring products. NASA and FAO will assist in placing these products into an operational context, developing a global fire monitoring system.

The new Chair of Terrestrial Carbon Observations (TCO), Riccardo Valentini, has made rapid progress in forming a new team, strategy and obtaining funding to implement activities, includingthe new CarboAfrica project which will improve the understanding of sources, sinks and fluxes of carbon in Africa. Riccardo's expertise in international environmental conventions makes him an ideal TCO chair, and he will assist in the many cross-cutting issues that need to be addressed.

The Terrestrial Observing Panel for Climate (TOPC) is supporting the development of the adequacy reports and the Implementation Plan for the Global Observing System for Climate (GCOS) for UNFCCC. The GTOS Secretariat has also been active in support of the convention, in particular for issues related to terrestrial climatic variables. The GTOS Coastal initiative has finalized its implementation plan, begun the execution of the identified priority products, and has now been endorsed to become a full GTOS Panel. In addition, the Terrestrial Environmental Monitoring Sites (TEMS) database continues to be expanded and key linkages are being established with other portals.

International Conventions

As outlined by the GTOS Chairman, supporting environmental conventions and initiatives have always been perceived as a priority area for GTOS. This gained renewed impetus during 2005, with the recruitment of a new staff member to specifically deal with these issues. The goal is to ensure that GTOS initiatives – including its products and services – are directly relevant to end users, including member countries. GTOS has a fundamental role in strengthening national capacity (through policy and technical advice) to deal with environmental and development issues, meet obligations under environmental agreements, and strengthen participation in global and regional environmental and natural resources management issues. A critical task is to identify and compile reliable data and indicators to allow us to understand and monitor environmental changes, as well as to assess progress being made. Understanding the linkages between human impact and pressures on the environment, employing environmental monitoring and assessment, are equally fundamental. The new GTOS biodiversity initiative currently being formulated will provide specific impetus in support of the requirements of environmental conventions, multilateral agreements and initiatives, as well as helping meet the multitudinous challenges implicit in global climate change.

Steering committee and evaluation

To help ensure that GTOS is true to its original mandate and maintains its relevancy as international activities rapidly evolve, the GTOS Steering Committee has been strengthened and an auto-evaluation process has been undertaken that will allow the refinement of the current strategy. The review process will also assess the viability of regional and national implementation strategies. This is felt to be an important process, as it should ensure the best use of limited resources and the identification of GTOS' strategic products, services and stakeholder groups.

Finally, I would like to thank the many individuals who have been involved in GTOS activities, especially the members of the different panels, initiatives and the secretariat, for their tremendous effort, long hours and hard work. Gratitude also goes to our many supporters and sponsors, especially the Government of Italy, for their considerable financial contribution to GTOS through its cooperation programme. May I also take this opportunity to thank the outgoing GTOS Chair,, Robert Scholes, for his efforts, and welcome the new GTOS Chair, Berrien Moore.

003

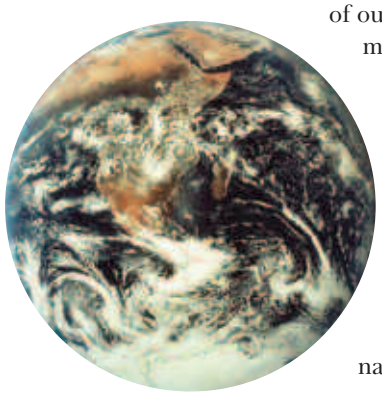
Giuseppe Deodato

The protection of our environment through the sustainable management of natural resources is one of the key issues in addressing poverty eradication and promoting economic growth

Italian Development Cooperation – a GTOS donor

Environmental protection and poverty eradication

The United Nations Millennium Declaration is central to the work of Italian Development Cooperation as it participates in the global effort to fight the various dimensions of poverty and to promote sustainable development. The protection of our environment through the sustainable management of natural resources is one of the key issues in addressing poverty eradication and promoting economic growth, in line with the Plan of Implementation of the World Summit on Sustainable Development (WSSD) The comprehensive programme to combat poverty and desertification in the Sahel is an example of the commitment of Italy to defining strategies and policies for natural resources management within the precepts of sustainable development.



Technical assistance and capacity development

In sub-Saharan Africa – the main beneficiary of Italian Development Cooperation – the sustainable management of natural resources is considered crucial for development, as emphasized by the Commission for Africa. The Istituto Agronomico per l'Oltremare (IAO), the technical and scientific branch of the Italian Ministry of Foreign Affairs, has been providing technical cooperation and capacity development to many developing countries in the thematic areas of sustainable agriculture and food security; geospatial information technologies; natural resources management; poverty alleviation; and issues related to biodiversity, biotechnology and biosafety.

This biennium has provided opportunities to reflect on issues related to the IAO mandate in a broad context through a series of events and activities to mark the IAO centennial anniversary, including the workshop on *Land Cover Mapping and Change Assessment: Applications, policies and networks in support of sustainable development* organized by IAO and United States Agency for International Development (USAID) in collaboration with FAO and UNEP (21–23 September 2004). This event demonstrates the importance attributed by the Government of Italy to the production, standardization and exchange of environmental data.

Support to the Global Terrestrial Observing System

Becoming a donor of GTOS is part of the overall strategy of Italy of facilitating the flow of environmental data and information in favour of sustainable development. Strengthening the GTOS Secretariat will also allow awareness raising and assessment of the requirements of the various international Conventions and multilateral environmental agreements. It is also important to recall the side event organized during the 3rd Session of the Committee for the Review of the

COOPERAZIONE ITALIANA

Photos from top left clockwise: FAO/18799/I. Balderi; FAO/19649/G. Bizzarri; FAO/19471/G. Bizzarri; FAO/10255/ F. Mattioli

Italian Development Cooperation

FAO/19677/G. Bizzarri

FAO/19619/G. Bizzarri

FAO/19204/Peyton Johnson

FAO/16913/G. Thomas

Implementation of the United Nations Convention to Combat Desertification (UNCCD), where representatives from many institutions (including IAO, Italian Development Cooperation and the University of Tuscia) discussed the role of GTOS, AfriCover and the Global Land Cover Network (GLCN) within UNCCD reporting, and the fight against desertification. This is an issue of considerable concern to the Government of Italy being both a donor and an affected country within UNCCD.

The fight against the degradation of our environment can only be won through a coordinated effort within an international mechanism, such as GTOS and its Co-Sponsoring Organizations, in order to leave a better and healthier planet to future generations.

Italian Development Cooperation: www.esteri.it/eng/4_28_66_71.asp

United Nations Millennium Declaration: www.un.org/millennium/declaration/ares552e.htm

WSSD: www.johannesburgsummit.org/html/documents/summit_docs/2309_planfinal.htm

IAO: www.iao.florence.it/documentation/landcovermapping/default.php

An international partnership leading a worldwide effort to build comprehensive, coordinated and sustained observations of the earth system

Group on Earth Observations

The Earth Observation Summit

During the G8 meeting in June 2003 (Evian, France) it was noted that there was a need to strengthen international cooperation on global observations to produce reliable data products covering the atmosphere, land, fresh water, oceans and ecosystems.

The first Earth Observation Summit (EOS) in July 2003 (Washington DC, United States of America) subsequently endorsed a statement of commitment to develop a comprehensive, coordinated and sustained earth observation system or systems. Such a system would directly support policy and decision-making and contribute to realization of the goals of the World Summit on Sustainable Development (WSSD), the Millennium Development Goals (MDGs), international conventions and other national and international efforts.

GEOSS 10-year implementation plan

The Group on Earth Observations (GEO) was established to coordinate and prepare a 10-year implementation plan for what became known as the Global Earth Observation System of Systems (GEOSS). Nine Societal Benefit Areas were identified (see box far right) and great efforts are being made to build on existing systems and initiatives to develop a comprehensive, coordinated and sustained programme of observations supporting each Societal Benefit Area. The Plan also includes sections dealing with system architecture, capacity building and outreach. The Implementation Plan has identified around 240 tasks, which have been prioritized for short- (1–2 years), medium- (3–5 years) or longer-term (5–10 years) implementation. The plan was endorsed at the 3rd EOS (Brussels, Belgium, February 2005).

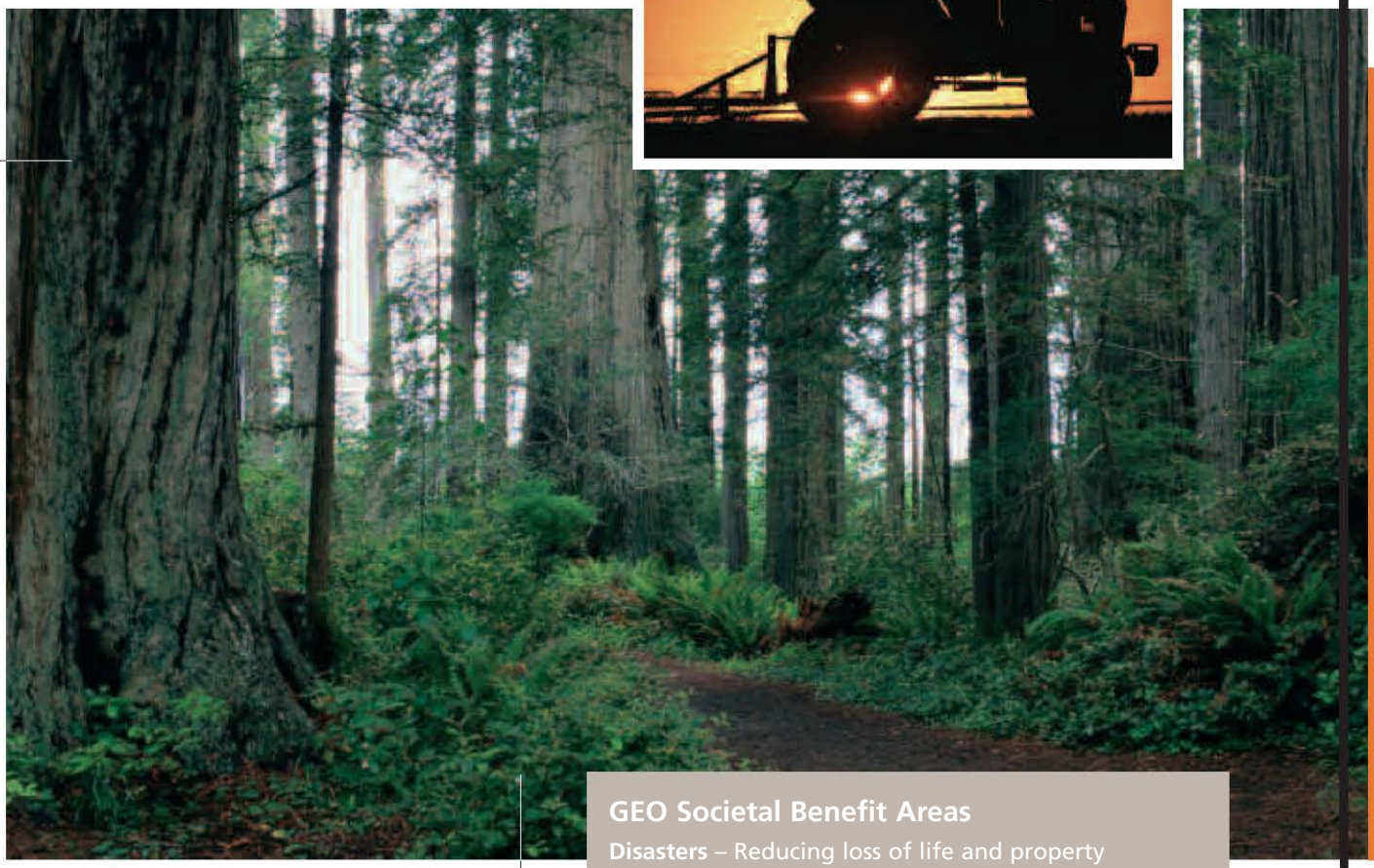
"...realize a future wherein decisions and actions for the benefit of human kind are informed via coordinated, comprehensive, and sustained Earth observations..."
(GEOSS 10-Year Implementation Plan)

GEO Members

58 nations

The European Commission

43 international organizations



GTOS contribution

From the beginning, GTOS has welcomed the GEOSS process as it has the political endorsement and support to carry out the important role of coordinating the huge number of national and international activities in the development of the products and data required by end users. GTOS and its Panels have been active in assisting in development of the Societal Benefit Areas, the 10-year implementation plan, and the programmes to implement the short-term objectives, including the implementation of the tasks and activities of the annual work plans. In addition, GTOS is ensuring that its activities comply with and are relevant to GEO objectives and requirements, as well as assisting in the creation of the required networks and infrastructure (see section on IGOL for an example).

GEO Societal Benefit Areas

Disasters – Reducing loss of life and property from natural and human-induced disasters.

Health – Understanding environmental factors affecting human health and well-being.

Energy – Improving management of energy resources.

Climate – Understanding, assessing, predicting, mitigating and adapting to climate variability and change.

Water – Improving water-resource management through better understanding of the water cycle.

Weather – Improving weather information, forecasting and warning.

Ecosystems – Improving the management and protection of terrestrial, coastal and marine resources.

Agriculture – Supporting sustainable agriculture and combating desertification.

Biodiversity – Understanding, monitoring and conserving biodiversity.

"...to improve monitoring of the state of the Earth, increasing understanding of Earth processes, and enhance prediction of the behaviour of the Earth system."

(GEOSS 10-Year Implementation Plan)

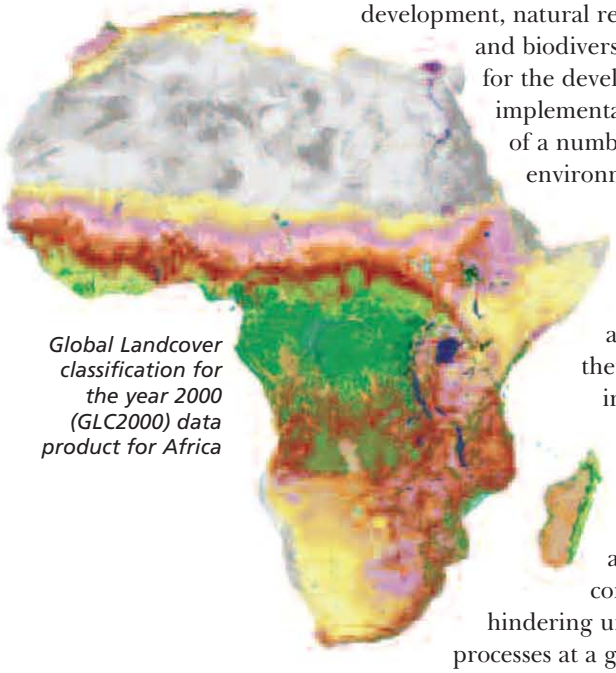
John Townsend, John Latham, Richard Conant, Angas Hopkins and Reuben Sessa

Identify the key land cover observations and data products needed by decision-makers

Land observation requirements

Why do we need an observation system for land?

Reliable observations of the terrestrial environment play a crucial role for sustainable economic development, natural resources management and biodiversity conservation, and for the development, implementation and monitoring of a number of multilateral environmental agreements. Vast quantities of observations of land are collected, but compared with the atmosphere and oceans there has been much less international coordination and standardization of observations, making country-by-country and region-by-region comparisons difficult and hindering understanding of land processes at a global scale.



Global Landcover classification for the year 2000 (GLC2000) data product for Africa

The IGOS Partnership

The Integrated Global Observing Strategy (IGOS) Partnership is a strategic planning process, involving a number of partners, that links research, long-term monitoring and operational programmes, data producers and data users in a structure that helps determine observation gaps and identify the resources required to fill observation needs.

IGOS Land Theme

In May 2004, the IGOS Partnership requested the development of an Integrated Global Observations for Land (IGOL) Theme. A team was established (see box) with the complex task of developing the IGOL theme report. The theme report will contain a comprehensive picture of the required observational requirements of stakeholders, the current status of observations, and gaps that need to be filled to ensure the capacity for long-term monitoring (see box).

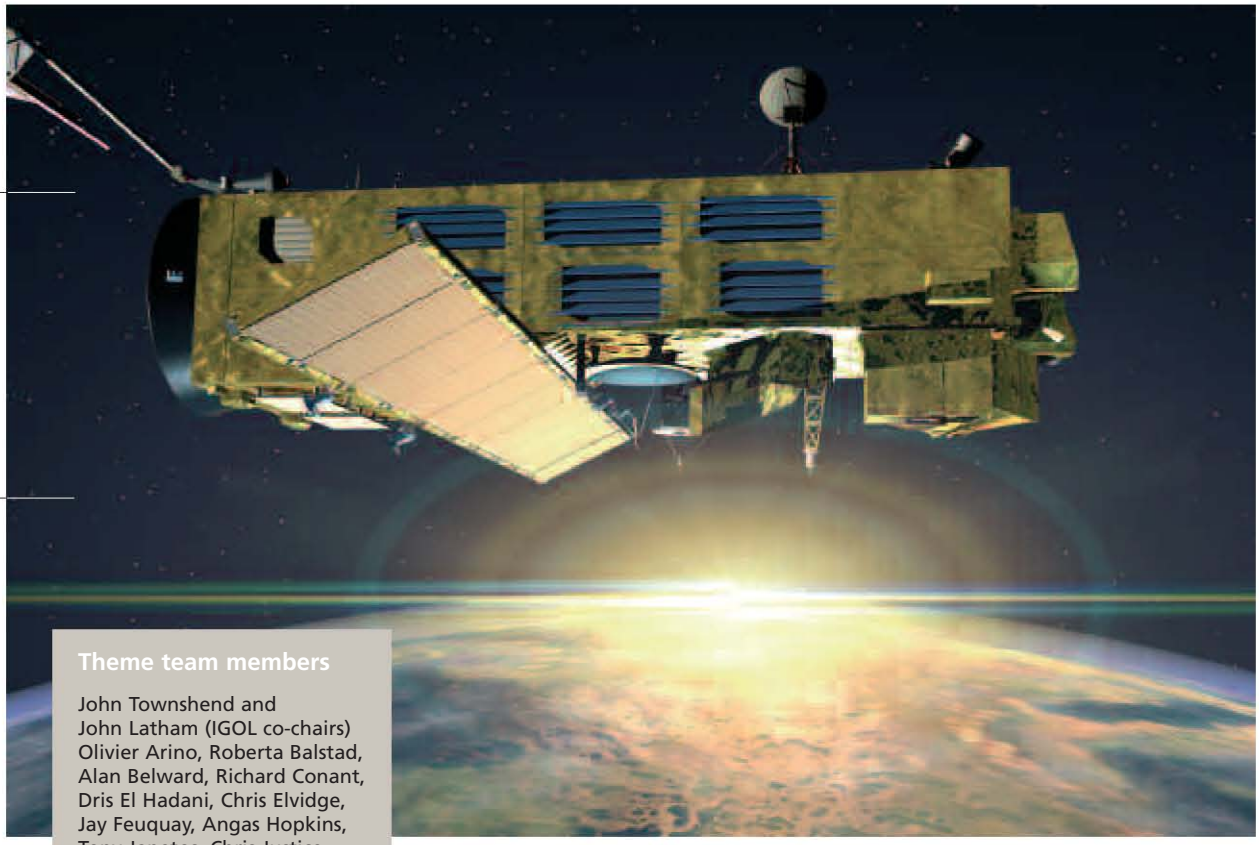
The scope of IGOL

The IGOL theme report will propose building on current initiatives and existing monitoring programmes linked to relevant research programmes to ensure that the best possible products are produced, and that these products are made available to a wide range of users at the national and international level.

Contribution to GEOSS

In developing IGOL the theme team have taken into consideration the requirements of a number of stakeholders, including the Global Earth Observation System of Systems (GEOSS). The report will highlight the required national- to global-scale products and the satellite, *in situ* and socio-economic observations needed to meet current and future societal requirements.

ESA Envisat, advanced polar-orbiting Earth observation satellite, which provides measurements of the atmosphere, ocean, land, and ice (ESA).



Theme team members

John Townshend and
John Latham (IGOL co-chairs)
Olivier Arino, Roberta Balstad, Alan Belward, Richard Conant, Dris El Hadani, Chris Elvidge, Jay Feuquay, Angas Hopkins, Tony Janetos, Chris Justice, Jiyuan Liu, Mengxue Li, Tom Loveland, Doug Muchoney, Dennis Ojima, Christiana Schmullius, Reuben Sessa, Ashbindu Singh, Jeff Tschirley and Kirokazu Yamamoto

Progress in developing IGOL

The Theme Team has been developing the report since May 2004, through a number of technical meetings. The first meeting of the Theme Team was in Rome, Italy, in September 2004, and a second meeting was convened in Reston, Virginia, United States of America, in July 2005 to consider the preliminary draft report. A final IGOL Theme Team meeting was held in Beijing, China, in February 2006 to finalize the scope of the report, to develop a full draft, and to begin refining the text. Additional meetings have been held to develop particular sections and topics of the report: a biodiversity-focus meeting was held in Washington DC, United States of America, in November 2005, and an Agriculture Monitoring workshop was held in March 2006. It is expected that the final report will be available in late 2006. The recommendations of the IGOL theme report will assist Group on Earth Observations (GEO) in identifying the critical observations, coordinating the relevant institutions and organizations, and ensuring that the gaps are filled, thus ensuring the delivery of the requisite high quality information products in a timely fashion.

Preliminary theme report structure

1. Introduction and executive summary
2. The needs for IGOL
   - Agriculture, forestry, combating desertification
   - Ecosystem goods and services
   - Biodiversity and conservation
   - Human health
   - Water resource management
   - Disasters
   - Energy
   - Urbanization
3. Stakeholders
   - International requirements
   - Governments
   - Civil society, including NGOs
   - Scientific requirements
4. Relationship of IGOL with other IGOS themes
5. Products and observables
   - Land cover and land cover change
   - Land use and land use change
   - Ecosystem dynamics and biophysical properties
   - Biodiversity
   - Agricultural production (forestry, food and fibre)
   - Soils
   - Human settlements (subcategories: tenure, farming systems)
   - Water availability and use
   - Topography (and related datasets)
6. Integration issues
   - Validation and quality assessment
   - Data model fusion requirements
   - Data assimilation
7. Delivering information (products)
   - Data and product access
   - Data and information delivery systems
8. Capacity building
9. Implementation
   - Strategy
   - Roles and responsibilities

John Townshend
and Michael Brady

Forest and Land Cover Dynamics

Introduction

The GTOS Panel on Global Observation of Forest and Land Cover Dynamics (GOFC-GOLD) is a coordinated international effort to ensure a systematic long-term programme of space-based and *in situ* observations of land cover and forest change, including the role of fire. It is designed to help provide the data needed for global monitoring of terrestrial resources, study of global change, and improved natural resources management.

Fire observations in the Brazilian Amazon

Through implementation teams and regional networks, GOFC-GOLD develops contributory products at regional and global scales in two thematic areas: Land Cover Characteristics and Change, and Fire Monitoring and Mapping. Capacity is strengthened by working with regional networks, which provide guidance on regional needs and promote the transfer of technology and experience in Southeast Asia, Central and Southern Africa, northern Eurasia, Latin America and – more recently – in East Asia and West Africa. GOFC-GOLD activities are coordinated by the project office and members of the Executive Committee. In January 2004, Dr Michael Brady of the Canadian Forest Service was appointed as GOFC-GOLD Executive Director.

Revised strategy

In April 2005, GOFC-GOLD held its third Scientific and Technical Board meeting to review and refine the goals and functions of the Panel, developed originally in 1999. The Board reaffirmed the importance of GOFC-GOLD's goal of providing consistent, reliable information on land cover, and the nine primary functions of GOFC-GOLD were refined to accommodate current progress and new issues (see box).

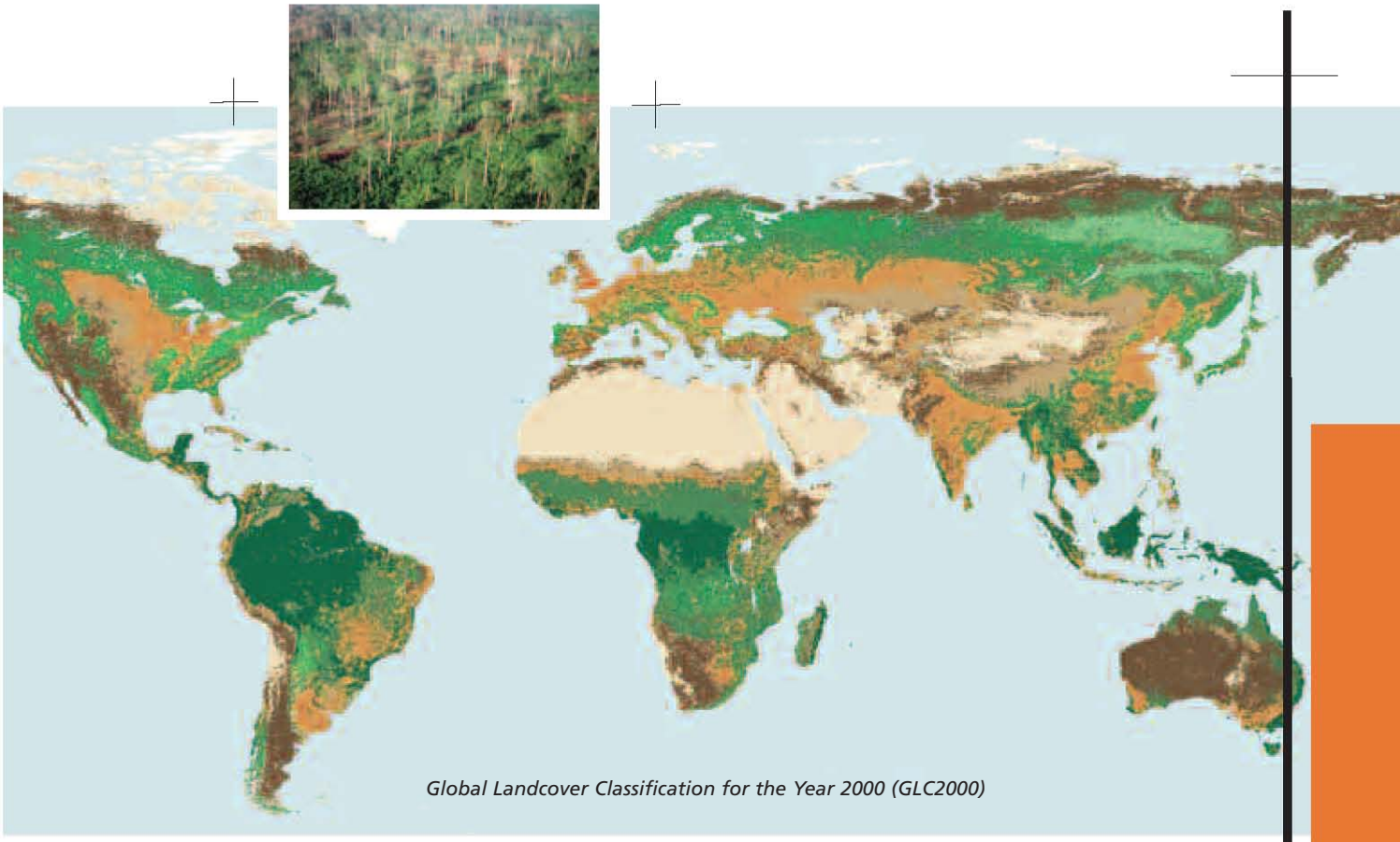
Fire Mapping and Monitoring

The key goals of the Fire Mapping and Monitoring theme are to ensure enhanced operational fire monitoring from space and ground measurements, better access to and use of data, and availability of standard products of known accuracy. The theme makes the best possible use of fire products to support fire management, policy decision-making and global change research.

The Fire theme is implemented by a team of international experts that works with the GOFC-GOLD regional networks to bring together fire data

GOFC-GOLD FUNCTIONS

1. Specifying requirements for products
2. Assessing algorithms and data assimilation procedures
3. Ensuring the availability of observations
4. Harmonization and development of protocols and standards
5. Ensuring that operational products meet accuracy requirements
6. Capacity building and the role of regional networks
7. Providing information to support international assessments
8. Creating GOFC-GOLD products and services
9. Advocacy, especially for continuity of observations and validation



Global Landcover Classification for the Year 2000 (GLC2000)

providers and users to exchange information on capabilities and needs and to promote strengthening of regional and national fire activities. Key achievements during the biennium include:

- reprocessing historical AVHRR satellite data to generate a fire disturbance data set (1982 to present);
- regional and global burned area products generated for recent years from SPOT/VGT, ATSR/AATSR and MODIS data;
- continuing generation from geostationary satellites of active fire and burnt area products, with known accuracy;
- global active fire datasets generated from ATSR/AATSR and MODIS;
- procedures developed for validating active fire products, and regional validation networks established for burned area products; and
- operational fire monitoring for Africa, being developed with FAO.

Land Cover Characteristics and Change

The Land Cover Characteristics and Change theme promotes the use and refinement of land cover data and information products for resource managers, policy-makers and scientists studying the global carbon cycle and biodiversity loss. The theme team works with the GOFC-GOLD regional networks to acquire high quality land cover data and to interact with users and regional experts to develop and implement mapping standards, data assimilation and product dissemination.

GOFC-GOLD has proposed a programme of annual coarse resolution (250–1000 m) earth observations, fine-scale land cover mapping (~25 m) on a 5-year cycle, and integration with *in situ* observations on global scales. Key achievements during the biennium include:

- corresponding archives of high resolution images for mapping rapidly changing land cover in selected areas;
- draft international protocols for *in situ* validation of land cover products, in cooperation with the Land Product Validation subgroup of the CEOS Working Group on Calibration and Validation; and
- an international framework for harmonizing and validating existing and future global and regional land cover datasets using the Land Cover Classification System (LCCS), in cooperation with FAO.

Current and emerging priorities

Additionally to its regular activities, GOFC-GOLD has directed efforts towards:

- steering the development of an international land-earth observation satellite network composed of multiple satellites with 30-m (or better) capabilities;
- supporting international environmental conventions;
- developing the land theme of the Integrated Global Observing Strategy (IGOS);
- formulating the Implementation Plan for the Global Climate Observing System (GCOS IP); and
- supporting implementation of the Global Earth Observation System of Systems (GEOSS).

Work with *in situ* monitoring services and satellite agencies to ensure that the gaps identified are filled

Climate observations

Overview

The Terrestrial Observing Panel for Climate (TOPC) is part of the Global Terrestrial Observing System and the Global Climate Observing System. TOPC liaises with relevant research and operational communities to identify measurable terrestrial properties and attributes that control the physical, biological and chemical processes affecting climate, are themselves affected by climate change, or serve as indicators of climate change.

A major milestone in meeting the TOPC objectives was the completion of the second report on the adequacy of the current climate observing system, prepared for the Conference of the Parties to the UN Framework Convention on Climate Change. This document identified the needs – and, unfortunately, the gaps – in our current climate observing system.

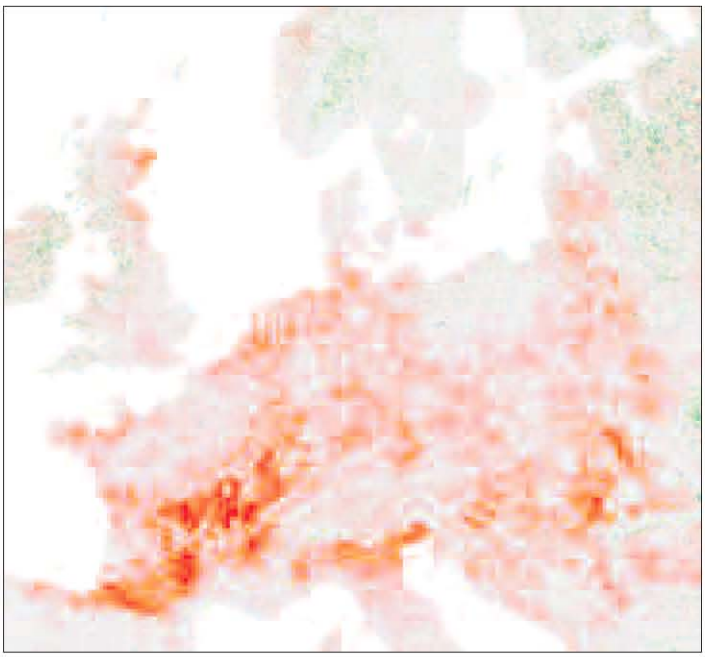
The response from the Parties was to ask for a ten-year Implementation Plan that would eliminate gaps and provide the climate observations needed to support the goals of the Convention. During 2004–2005, TOPC provided the terrestrial components of this plan.

Implementation progress

The Global Runoff Data Centre (GRDC) has identified a network of 380 key rivers worldwide where river discharge monitoring is essential: the Global Terrestrial Network for Rivers (GTN-R). The 80 hydrological services responsible for these rivers have been contacted and GRDC is beginning to receive updates of historical data for some rivers (see http://gtn-r.bafg.de/?10141).

Two offers to host a global lakes database – documenting area, levels, temperatures freeze and thaw dates and other lake measurements (Russia and Canada) – have been received by TOPC. Without such central repositories, it will be impossible to build a long-term view of changes in a crucial part of our planet's freshwater resource.

Space agencies, through their Committee for Earth Observation Satellites (CEOS), have agreed to provide multi-decadal climate products covering the terrestrial, oceanic and atmospheric domains wherever possible. Although discussions continue, advanced product generation has begun in critical terrestrial areas, including burn scars, land cover, fraction of absorbed photosynthetically active radiation (FAPAR) and land-surface albedo. However, internationally agreed validation protocols and benchmarks are not always available for terrestrial climate variables. TOPC and other GTOS science panels, especially GOFC-GOLD, are collaborating with the CEOS' Working Group on Calibration and Validation to establish such protocols and benchmarks. Formal intercomparison exercises have begun among FAPAR measurements from a range of sensors, and for directional hemispherical reflectance factor (or black sky albedo) products generated from polar orbiting and geostationary satellites. A report describing validation protocols for land cover products has been completed, and selected space agencies have made commitments to the generation of new global land cover datasets at resolutions of 250–300 metres, a significant improvement on currently available global land cover maps.



Anomalies in the fraction of absorbed photosynthetically active radiation (FAPAR) over Europe for August 2003, compared with mean levels for the previous five years. The red tones identify severe levels of ecosystem stress, as indicated by greatly reduced levels of plant photosynthesis (the far more limited blue-green areas identify regions where photosynthetic activity was actually higher than average). The year was one of the hottest and driest on record: new temperature maxima were reached; river flows were the lowest ever recorded; crop yields were severely reduced; and hundreds of thousands of hectares of forest were destroyed by fire. Data are available at http://fapar.jrc.it/.

Future orientations

TOPC will continue to work with space agencies to help ensure that optimum use is made of earth observing satellite data for monitoring the terrestrial component of our climate system. Work will continue with *in situ* monitoring services to ensure, for example, that gaps identified in the global glacier and permafrost monitoring networks are filled, and TOPC will continue to work with GTOS and GCOS' sponsors – especially FAO and WMO – on the establishment of a formal process for issuing technical guidelines for terrestrial observations.

TOPC: www.wmo.int/web/gcos/topc.htm
TOPC: www.fao.org/gtos/TOPC.html
FAPAR: http://fapar.jrc.it/
GTN-R: http://gtn-r.bafg.de/?10141

Riccardo Valentini
and Antonio Bombelli

A new carbon network strategy
in response to user requirements

Terrestrial Carbon Observation (TCO)

Introduction

The terrestrial carbon cycle is spatially and temporally extremely heterogeneous and variable due to species, climate, management and disturbance regimes. Terrestrial uptake and release of carbon are also totally decoupled in terms of temporal dynamics: release of carbon through oxidation is fast, occurring mostly through disturbances (fires, pests, harvesting, etc.), while accumulation of carbon through photosynthesis is slow and can take centuries. The terrestrial biota needs to be managed to increase carbon sequestration and help achieve mitigation of greenhouse gas (GHG) emissions.

Photo: FAO/14185/R.Faidutti

TCO role

In response to increasing awareness of perturbation in the global climate system and the entry into force of international environmental treaties, there is an urgent need to understand, predict and quantify the global carbon budget and its temporal and spatial behaviour. TCO's overarching goals are to better identify the potential end users, and their requirements; organize and coordinate reliable data and information on carbon; and link the science community with potential users.
TCO considers three broad categories of information (*in situ*; satellite; and terrestrial ecosystem data) from the local to the regional and global scales, providing information on the spatial and temporal distribution of terrestrial carbon sources and sinks.

New TCO scope

While process understanding and prediction of future climate feedbacks and vulnerabilities associated with terrestrial carbon are the primary focus of science programmes, the new TCO mission is to focus on specific products, such as: an operational database system; validated and parameterized models; manuals, standard methodologies and related documentation; productivity estimates; and the creation of a common forum for scientists and stakeholders interested in carbon accounting.

To avoid duplication and overlaps with other monitoring programmes, TCO – in collaboration with Integrated Global Carbon Observation (IGCO) – plans to establish a post-doctoral position to work on terrestrial carbon which will be jointly supported by FAO and UNESCO, and to work in close collaboration with the Global Carbon Project (GCP).

TCO aims

- Launch a global database for information on terrestrial carbon and non-CO_2 GHG gases and their spatial and temporal breakdown. This database will be based on the flux tower network, TEMS, biomass and soil inventories, yield tables and remote sensing estimates; record frequency and intensity of leakages from disturbances (deforestation and fires); and contain current and solid models on terrestrial carbon fluxes.
- Contribute to the harmonization and validation process by bridging the gap between data-oriented models and process-oriented models; validating models and reducing uncertainties; and validating remote-sensing products through *in situ* data.

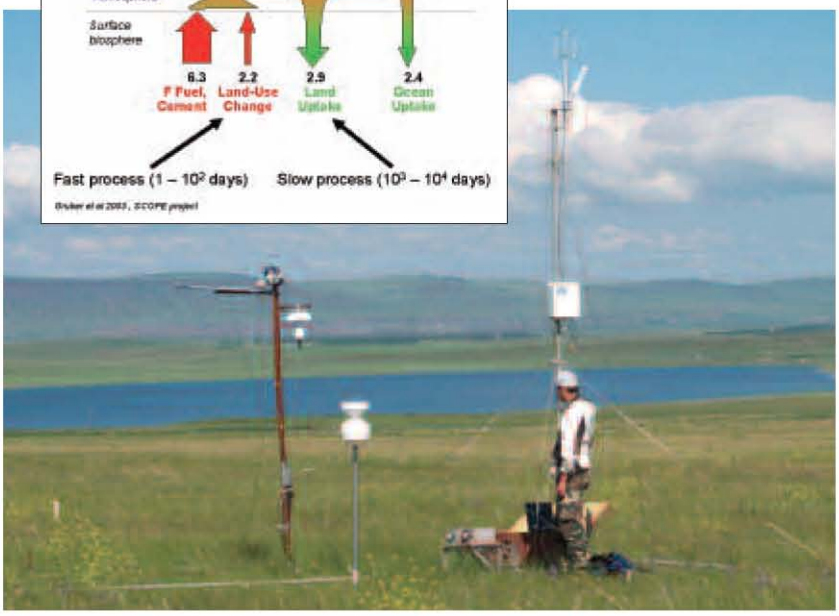


Photo: Luca Belelli Marchesini

Photo: Dario Papale

Röser et al., 2002. Tellus 54B, 642-654.

New TCO Chair

Riccardo VALENTINI. Department of Forest Science and Resources (DISAFRI), University of Tuscia, Italy.

Riccardo Valentini is currently Professor at DISAFRI. His expertise concerns forest ecology and biogeochemistry, particularly carbon balance estimation by means of different methodologies, including eddy covariance measurements and models. He participates as chairman, coordinator or scientific representative in many international environmental agreements, and in European and international programmes.

- Test the methodological approach of carbon accounting at various spatial scales, with a specific emphasis on the regional scale, and ensure comparability amongst regions having different socio-economic and environmental contexts. TCO will identify regions where coverage is lacking and promote action to rectify these deficiencies. Regional examples should include Central and Southeast Asia, Amazonia, the Euro-Siberian region, and Africa. To this end, the CARBOAFRICA project (funded by the 6th Framework Programme of the European Union) will expand the existing flux network in the under-represented region of sub-Saharan Africa.
- Promote the inclusion of the avoided deforestation in the framework of the UNFCCC and its Kyoto protocol by: a monitoring network of in situ observations on biomass; a feasibility study on the cost of the maintenance of this network; the identification of the optimal time period for the baseline and monitoring; and the validation of models linking the size of deforested areas (remote sensed) with carbon emissions.
- Support multilateral environmental conventions, not only responding to their requests, but also providing suggestions, instruments and products useful for environmental and socio-economic purposes.
- Provide a clearinghouse for initiatives contributing to meet the requirements of the Millennium Development Goals (MDGs) and the Rio Conventions, through drawing together indicators and methods on evaluation of multiple benefits of terrestrial carbon projects relative to mitigation strategy, the fight against desertification, and support to biodiversity conservation. Particular attention will be focused on an effective mechanism for practicable functioning of the clearinghouse in developing countries.
- Develop dissemination and capacity building, focusing mostly on the higher education sector and on methodological and institutional aspects of terrestrial carbon management. An international initiative will be launched to mobilize resources to form a common pool to support PhD students in developing-country universities (a "Carbon School"). The visibility of results and the possibilities for funding will be increased using the Web and involving young people.

UNIVERSITÀ DEGLI STUDI DELLA Tuscia

TCO is supported by the University of the Tuscia.

TCO: www.fao.org/gtos/TCO.html
University of Tuscia: http://gaia.agraria.unitus.it/

Robert R. Christian
and Stefano Mazzilli

To detect, assess and predict global and large-scale regional change associated with land-based, wetland and freshwater ecosystems along coasts

GTOS Coastal Panel

Why highlight observations of coastal ecosystems?

Coasts, bordering the world's greatest water bodies, are among the most important areas in the world to humans, and one of the most sensitive to anthropogenic impact at local to global scales. There is a clear need for information on global and regional change in coastal areas. Collection of *in situ* and remote sensing data must be improved and associated data management, model production and communication infrastructure developed to provide free and timely information to developed and developing nations. Hence, the Global Terrestrial Observing System (GTOS) has developed a Coastal Panel (C-GTOS) in collaboration with other coastal programmes and international initiatives.

Development of a Coastal Observing System

Substantial progress has been made developing and implementing C-GTOS. The C-GTOS Strategic Design and Phase 1 Implementation Plan has been published. This was followed by the initiation of a full Coastal Panel, endorsed by the GTOS Steering Committee at its January 2006 meeting. The endorsed Terms of Reference propose a future joint GTOS/GOOS (Global Ocean Observing System) Coastal Panel. Development is underway on the five priority products for the immediate implementation of C-GTOS. Here we highlight two of these products.

Informatics and ecosystem services in deltaic systems with respect to climate change and dam impact

A series of digital maps is being developed demonstrating informatics and spatial modelling methods for estimating ecological functions in deltas. Initial implementation includes the modelling and mapping of a limited group of deltas and building a consortium to promote data sharing, international cooperation and financing. John Kineman (University of Colorado) has led this work, initiating the World Deltas Network (WDN) and preliminary activities, working with George Hart and Jim Coleman (Louisiana State University) and the Global Land Cover Network (GLCN). Achievements include:

- The launch of the WDN website by Kineman, and the development of the World Deltas Database (WDD), designed by Hart, which incorporates data from Coleman, Brau, Hart and Hu.
- An initial study of 12 deltas using geophysical analysis to produce delta extent maps (see WDN website).
- A pilot study for the Nile Delta, Egypt, is underway, including mosaicking of satellite data from three decades of data collection (1980, 1990 and 2000). These datasets will be made available for download from the WDN website.
- Preliminary analysis of ecosystem services and vulnerability in the Nile Delta is underway, using the Land Cover Classification System (LCCS) of FAO and UNEP (Figure 1).

Vulnerability of ecosystems in deltaic systems

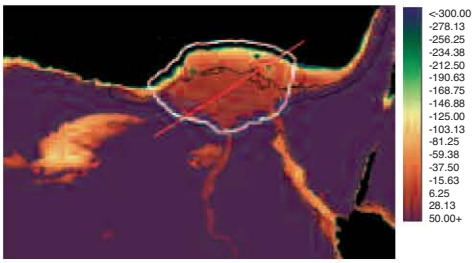


Figure 1. Geophysical analysis of Nile delta to produce delta extent map

Figure 2. Land cover and ecosystem function analysis

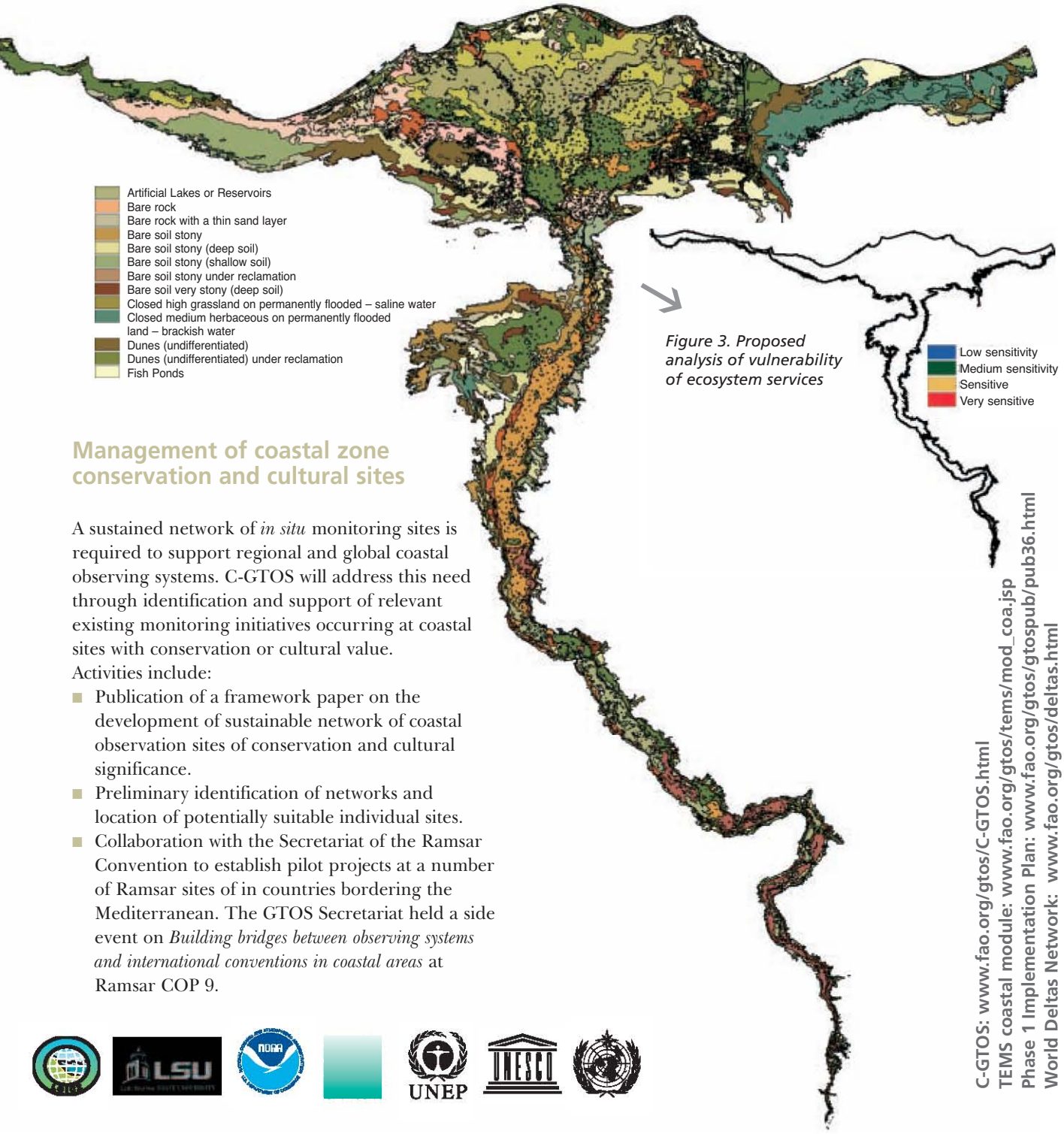


Figure 3. Proposed analysis of vulnerability of ecosystem services

Management of coastal zone conservation and cultural sites

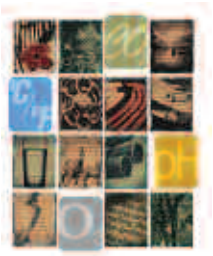
A sustained network of *in situ* monitoring sites is required to support regional and global coastal observing systems. C-GTOS will address this need through identification and support of relevant existing monitoring initiatives occurring at coastal sites with conservation or cultural value. Activities include:

- Publication of a framework paper on the development of sustainable network of coastal observation sites of conservation and cultural significance.
- Preliminary identification of networks and location of potentially suitable individual sites.
- Collaboration with the Secretariat of the Ramsar Convention to establish pilot projects at a number of Ramsar sites of in countries bordering the Mediterranean. The GTOS Secretariat held a side event on *Building bridges between observing systems and international conventions in coastal areas* at Ramsar COP 9.

C-GTOS: www.fao.org/gtos/C-GTOS.html
TEMS coastal module: www.fao.org/gtos/tems/mod_coa.jsp
Phase 1 Implementation Plan: www.fao.org/gtos/gtospub/pub36.html
World Deltas Network: www.fao.org/gtos/deltas.html
World Deltas Database: www.geol.lsu.edu/WDD/

WDD designed by Hart AND Coleman.

Paolo Prosperi
and Aurelien Letourneau



Terrestrial Ecosystem Monitoring Sites (TEMS)

Coastal module developments

Since 2003, TEMS has grown steadily and evolved conceptually to incorporate a number of new features (see box 1 and box 2). In collaboration with Coastal GTOS, the TEMS costal module has been updated including the new function of selecting coastal terrestrial monitoring sites (T.sites) within 5, 10 and 50-km buffer zones as well as sites within a 100-km zone below 100 m above sea level. This will improve the relevance of TEMS for collaborating networks and support regional and global programmes.

Metadatabase content

Following a 2004 survey among TEMS users, GTOS Secretariat moved ahead with implementation of a new service to provide a Web-based Digital Elevation Model (DEM) for each registered T.site. The final result will be a three-dimensional model of any relevant 10x10 km area, with superimposed Landsat ETM+ and, as available, MSS, TM imagery and land cover vector layers. This represents a significant improvement in the information content offered by TEMS.

Box 1. What is TEMS?

The TEMS database is an international directory of sites and networks that carry out long-term terrestrial monitoring and research activities. The database provides information on the "who, what and where" that can be useful to both the scientific community and to policy-makers, including the major environmental conventions.

TEMS originated in the late 1980s as the Global Environment Monitoring System of UNEP, Nairobi. The GTOS Secretariat has been managing and developing the database since 1996, with technical support from FAO.

Collaboration and improvements

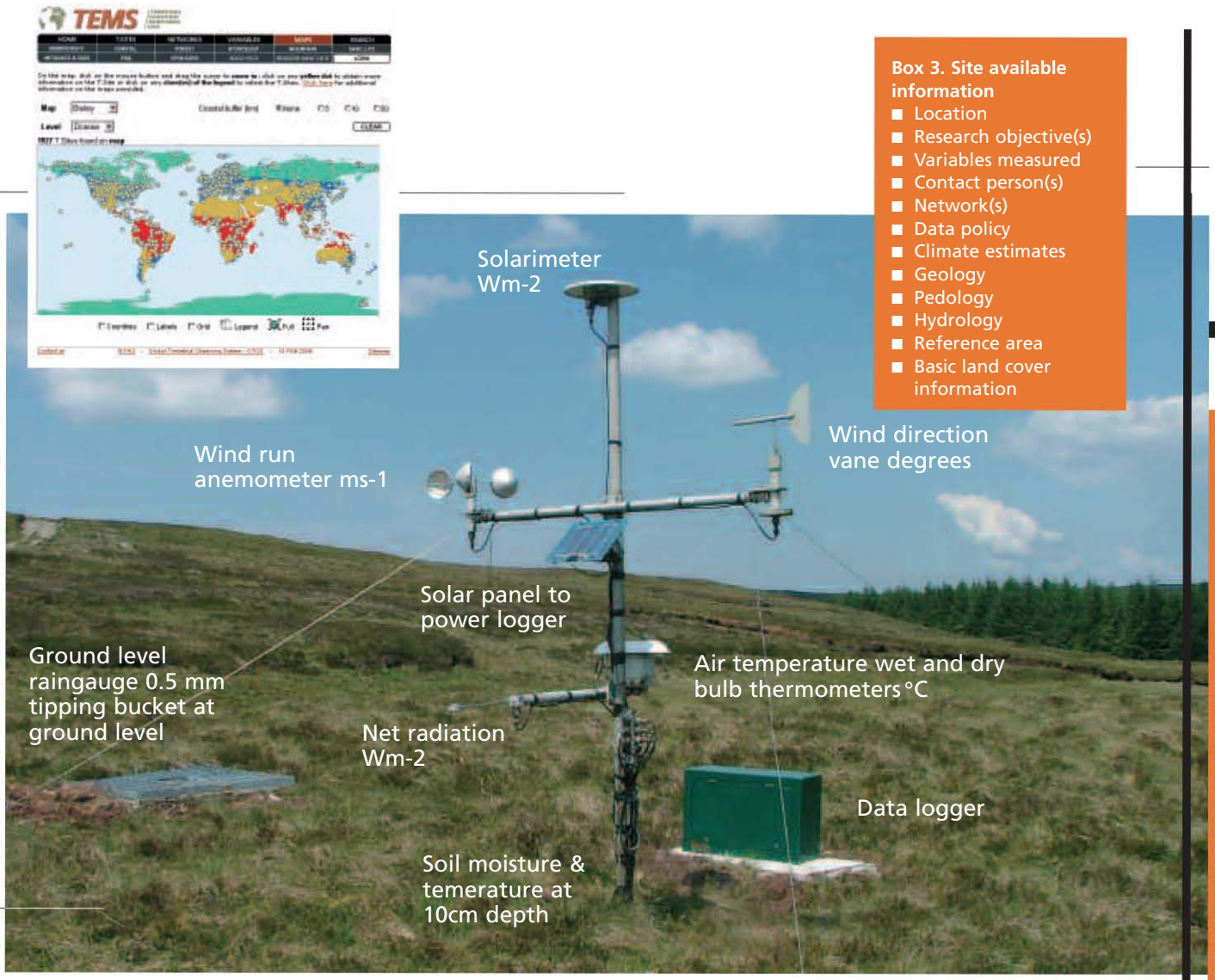
- A mountain module has been introduced as a follow-up initiative to the International Year of Mountains 2002.
- An improved search engine now allows users to retrieve the T.sites based on the major environmental topics and on country or network.
- New online video tutorials show how to benefit from TEMS and its functionalities, and how to register and update site information through the Web site.
- A new navigation bar facilitates access to the thematic modules.
- A new version (v.3.0) of the TEMS CD-ROM has been finalized and a print run authorized.
- Contacts have been established between TEMS and the Global Terrestrial Network – Hydrology (GTN-H) and UNESCO's Man and the Biosphere (MAB) Programme for future collaboration.

Integration with other programmes GOSIC/GTOS/GCMD data matrix

The Global Observing Systems Information Center (GOSIC), the NASA Global Change Master Directory (GCMD) and TEMS have developed a matrix to access selected datasets registered in the GCMD according to the TEMS topics and its associated variables. The matrix is displayed as a Web-based search tool – see www.gosic.org/ios/GTOS_observing_system.asp

Box 2. TEMS features – the metadata for environmental monitoring activities

- 2040 monitoring sites.
- 40 networks.
- 1200 contact persons.
- 120 environmental variables and 55 socio-economic indicators (with descriptor sheets).
- Thematic modules on hydrology, biodiversity, coastal zones and mountain issues.
- Online registration and update of T.sites data and information.
- Video and audio tutorials.



Box 3. Site available information

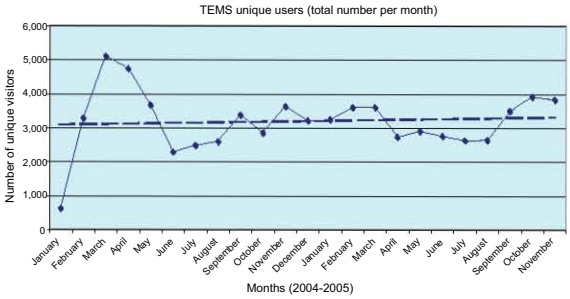
- Location
- Research objective(s)
- Variables measured
- Contact person(s)
- Network(s)
- Data policy
- Climate estimates
- Geology
- Pedology
- Hydrology
- Reference area
- Basic land cover information

EcoPort

Following signature of a Letter of Agreement with the EcoPort Foundation, a test integration of TEMS into EcoPort was designed and implemented. Further integration and improvements are being discussed.

Web statistics

Data on use of the TEMS Web site in 2004–2005 are displayed graphically below. The superimposed trend line (dashed) shows how both numbers of unique visitors and average number of pages viewed increased in the biennium.

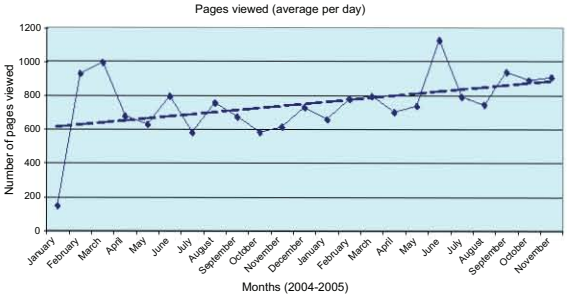


The future of TEMS

Numerous activities are being developed to render TEMS more efficient in responding to the needs of the user community.

The biodiversity and hydrology modules in TEMS are being improved and a Web-based user forum for discussion of relevant issues, exchange of data or suggestions will be implemented.

Collaboration will be strengthened with the FAO GeoNetwork initiative (with emphasis on metadata enhancement) and with EcoPort for a possible migration of the system.



Assisting the Conventions

Conventions: a land-based approach to promote synergy

The States that are Parties to environment-related international Conventions have been identified as potential users of the Global Terrestrial Observing System (GTOS) since its inception. Recently, focus has been on raising awareness of GTOS products and services amongst delegates from State Parties and observer organizations during statutory meetings.

GTOS proposes to provide support to the various Conventions through a common thread based on issues related to trends in land cover and land use. All GTOS Panels are expected to cooperate in this endeavour. The approach will be framed within the Plan of Implementation of the World Summit on Sustainable Development and its emphasis on synergy among environment-related Conventions in addressing climate change, biodiversity loss, desertification and land degradation.

Rio Conventions

GTOS has worked towards the assessment of reporting needs of the State Parties to the UN Convention to Combat Desertification (UNCCD) and the promotion of harmonized collection, analysis and exchange of relevant information related to land degradation. GTOS can also provide a strong practical contribution to analysis relating to deforestation issues, setting up a monitoring network of *in situ* observations and modelling estimates of biomass data, suggesting a suitable time interval for baseline and the monitoring activities, and assessing the emission of greenhouse gases (GHGs) from deforestation activities.

As requested by the Conference of the Parties of the UN Framework Convention on Climate Change (UNFCCC), a report was made to its Subsidiary Body for Scientific and Technological Advice on the progress made in the development of a framework for the preparation of guidance materials, standards, reporting guidelines, and associated data and products for terrestrial observing systems. The occasion was taken to re-affirm GTOS commitment to assisting UNFCCC, in close partnership with GCOS, in meeting its long-term objective to stabilize GHG concentrations in the atmosphere and to assist member countries to meet their obligations and to confront the effects of climate change.

GTOS recognizes the linkages between climate change and biodiversity in the its cooperation with the Convention on Biological Diversity (CBD), as well as issues related to coastal biodiversity and connectivity or fragmentation of terrestrial ecosystems.

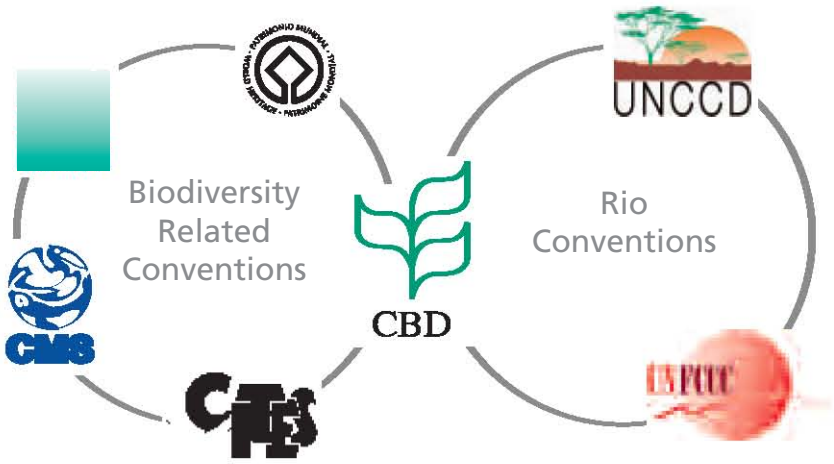
Biodiversity-Related Conventions

Within the framework of reducing the current rate of biodiversity loss, GTOS has been working together with the Secretariat of the Ramsar Convention on Wetlands and its Mediterranean Wetlands Committee to identify activities for joint implementation. A Memorandum of Cooperation between GTOS and the Convention was announced by the Secretary-General of the Ramsar Convention, Dr Peter Bridgewater, when opening the GTOS side event during the 9th Meeting of the Conference of the Parties to the Ramsar Convention. TEMS, Coastal-GTOS and the GLCN were identified as the leading initiatives in cooperation with the Ramsar Convention and as exploratory tools for partnership with the Convention on Migratory Species of Wild Animals (CMS) and CBD.

GTOS has been assessing its role in support of CMS requirements in terms of facilitating the provision of data and information needed to review major threats to migratory species and obstacles to migration, through the integration of *in situ* and remote-sensing terrestrial observations. These issues were presented at the *CMS Partnership Fair: On the move to 2010* held during the 8th Meeting of the Conference of the Parties to the Convention.

In addressing issues on climate change, biodiversity loss and land degradation, GTOS takes into account the work of both the Biodiversity Liaison Group and the Joint Liaison Group, and the linkages among the environment-related Conventions.

GTOS would like to thank the Secretariats of CBD, CITES, CMS, Ramsar Convention, UNCCD, UNFCCC, and World Heritage Convention for permission to use the relevant logos in this publication.



2005 meetings

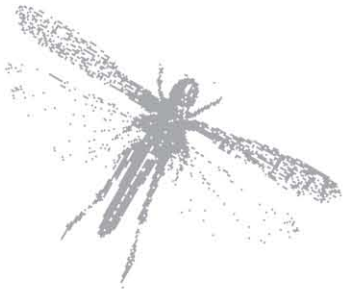
- 3rd Session of the Committee for the Review of the Implementation of the Convention (CRIC-3) of the United Nations Convention to Combat Desertification (UNCCD), Bonn, Germany, 2–11 May 2005.
- 29th Session of the World Heritage Committee, Durban, South Africa, 10-17 July 2005.
- 9th Meeting of the Conference of the Contracting Parties of the Ramsar Convention on Wetlands, Kampala, Uganda, 8–15 November 2005.
- 8th Meeting of the Conference of the Parties to the Convention on Migratory Species of Wild Animals (CMS), Nairobi, Kenya, 20–25 November 2005.
- 11th Meeting of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA-11) of the Convention on Biological Diversity (CBD), Montreal, Canada, 28 November–2 December 2005.
- United Nations Climate Change Conference, Montreal, Canada, 28 November–9 December 2005.

Meetings planned for 2006

- 8th Ordinary Meeting of the Conference of the Parties to the Convention on Biological Diversity (CBD), Curitiba, Brazil, 20–31 March 2006.
- 34th Meeting of the Standing Committee of the Ramsar Convention on Wetlands, Gland, Switzerland, 10–13 April 2006.
- 24th Session of the Subsidiary Body for Scientific and Technological Advice (SBSTA) and the Subsidiary Body for Implementation (SBI) of the United Nations Framework Convention on Climate Change (UNFCCC), Bonn, Germany, 18–26 May 2006.
- 13th Meeting of the Scientific and Technical Review Panel (STRP) of the Ramsar Convention on Wetlands, Gland, Switzerland, 30 May–2 June 2006).
- 30th Session of the World Heritage Committee, Vilnius, Lithuania, 8-16 July 2006.
- 12th Conference of the Parties of the United Nations Framework Convention on Climate Change (UNFCCC) and 2nd Session of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (COP/MOP), Nairobi, Kenya, 6–17 November 2006.
- 5th Session of the Committee for the Review of the Implementation of the United Nations Convention to Combat Desertification (UNCCD), Buenos Aires, Argentina, September 2006.

Lucilla Spini
and Robert Scholes

Biodiversity loss: GTOS and Target 2010



Biodiversity loss: the 2010 Target

In 2002, the Conference of the Parties of the Convention on Biological Diversity (CBD) committed "to achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level as a contribution to poverty alleviation and to the benefit of all life on earth." Such a target – known as Target 2010 – was later endorsed in the Plan of Implementation of the World Summit on Sustainable Development (WSSD).

Mid-way to 2010, progress towards Target 2010 is being assessed through the identification of sub-targets and indicators. As explained in the *Biodiversity Synthesis Report* of the Millennium Ecosystems Assessment, it is unlikely that the Target will be achieved at the global level for all the components of biodiversity. However, the international community is working cohesively towards reducing the rate of biodiversity loss.

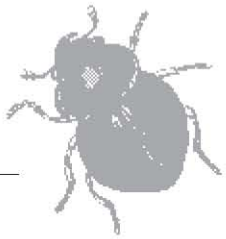
GTOS is contributing to this effort through the identification of products and services that will assist in determining progress towards Target 2010. GTOS, through its GOFC-GOLD panel on land cover change, can make particular contributions in relation to the extent, fragmentation and connectivity of ecosystems and habitats.

Mapping progress towards Target 2010

The role of a GTOS initiative on biodiversity was presented at a side event during the 11th Meeting of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA-11) of CBD. The event emphasized the potential for GTOS to promote synergy among the Rio Conventions and Biodiversity-Related Conventions through activities involving, *inter alia,* Coastal-GTOS, GOFC-GOLD and TCO.

GTOS has also been working towards clarifying methodological issues related to land cover dynamics and land use, and their application to the management of protected areas by taking into account the work undertaken within GOFC-GOLD, the Land Cover Classification System (LCCS) and the regional and national training activities of the Global Land Cover Network (GLCN).

While the topic of biodiversity loss has been in the GTOS mandate since its inception, neither Panels nor Initiatives have to date focused specifically on biodiversity, but the next biennium should see the establishment of the first building blocks of a GTOS Initiative for biodiversity observations at the global scale.



Biodiversity-GTOS

The Biodiversity GTOS Initiative (B-GTOS) is an outcome of the work by GTOS in assessing the needs of the global biodiversity community in achieving Target 2010, within the framework of Biodiversity-Related Conventions (CBD; Convention on Migratory Species of Wild Animals CMS; the Ramsar Convention on Wetlands; and the World Heritage Convention) and related multilateral environmental agreements.

B-GTOS will be launched in 2006 by convening an expert team. Their mission will be to develop an implementation plan that defines the GTOS biodiversity observation system. It will describe, *inter alia*, opportunities for integration of geospatial data and process-level ecology information. Among the first activities to be implemented are expected to be an enhancement of TEMS functionality with respect to biodiversity, by integrating it with the EcoPort Database.

B-GTOS: www.fao.org/gtos/B-GTOS.html
Target 2010: www.biodiv.org/2010-target/default.asp

Gregory B. Greenwood
and Claudia Drexler

Monitoring for global change research in mountains

Mountain Research Initiative

The Mountain Research Initiative (MRI) is a multidisciplinary scientific organization that addresses global change issues in mountain regions around the world. MRI is funded by the Swiss National Science Foundation (SNSF) and the Swiss Federal Institute of Technology (ETH Zürich), and endorsed by the International Geosphere Biosphere Programme, the International Human Dimensions Programme, GTOS and UNESCO's Man and the Biosphere Programme. MRI's vision is a global change scientific programme that detects the signals of global change, defines the consequences, and supports sustainable resource management.

GLOCHAMORE

The Global Change in Mountain Regions (GLOCHAMORE) project was supported by the EU's Sixth Framework Programme, and managed by MRI and the University of Vienna since 2003, with the support of scientists and site managers of more than 50 nations. The aim has been to develop an integrated and implementable research strategy that would enable better understanding of the causes and consequences of global change. Critical to strategy development was the participation of 28 UNESCO Mountain Biosphere Reserves (MBRs) and the integration of activities and knowledge from both natural and social sciences.

Thematic workshops

As part of GLOCHAMORE, MRI co-organized four thematic workshops (see below), focused on the four key global change research activities: monitoring; process studies; modelling; and sustainable natural resource management. These four activities were defined in the founding report of MRI (IGBP Report 49). Through these workshops MRI tapped the knowledge of global change researchers and reserve managers from industrialized and developing countries, as well as enhancing awareness of global change in the mountains community.

Monitoring

The monitoring workshop (Vienna, Austria, May 2004) proposed monitoring at several different intensities for the alpine cryosphere, mountain

The Mountain Biosphere Reserves participating in the GLOCHAMORE project

1. Denali , USA
2. Mount Arrowsmith, CAN
3. Olympic, USA
4. Glacier, USA
5. Niwot Ridge, USA
6. Cinturón Andino, COL
7. Huascarán, ARG
8. Araucarias, CHL
9. Torres del Paine, CHL
10. Oasis du Sud Marocain, MAR
11. Tassili N'Ajjer, DZA
12. Mount Kenya, KEN
13. Kruger to Canyons, ZMB
14. Lake Torne, SWE
15. Berchtesgarden Alps, DEU
16. Gossenköllesee, AUT
17. Gurgler Kamm, AUT
18. Entlebuch, CH
19. Swiss National Park, CHE
20. Sierra Nevada, ESP
21. Nanda Devi, IND
22. Issyk Kul, KGZ
23. Katunskiy, RUS
24. Uvs Nuur Basin, MNG
25. Changbaishan, CHN
26. Skikhote-Alin, RUS
27. Kosciuszko, AUS

(Map: Courtesy of UNESCO)

Recommended variables for snow, glaciers and permafrost to be recorded in mountain biosphere reserves.

Variable or Indicator	Minimum	Medium	Optimum	Sampling frequency
GLACIERS				
Mass balance (at selected stakes or snow pit)		✓	✓	Annually to seasonally
Length and area (remote sensing data)	✓	✓	✓	Multi-annually
Bed geometry			✓	Once
Flow (radio-echo sounding; velocity measurements)			✓	Annually to seasonally
Runoff (gauge station in catchment basin).		✓		Daily

waters and terrestrial ecosystems. An example taken from the workshop report for glaciers appears in the table top right.

Land use and land cover mapping and GIS

The modelling workshop (L'Aquila, Italy, November 2004) emphasized, *inter alia*, the importance of land use and land cover change (LUCC) mapping and GIS. Land use is such a fundamental feature of biosphere reserves and their environment that mapping rather than sampling is required. Beyond that, participants felt that without basic GIS skills and hardware at each biosphere reserve, it would nearly impossible for MBRs to monitor current conditions or project future conditions.

Socio-economic variables

Socio-economic monitoring was central to the workshop on sustainable development (Granada, Spain, March 2005). Minimal, medium and maximal lists of socio-economic indicators were generated, from simple population variables such as total number, age structure and gender structure, to more complex variables such as agricultural productivity and land tenure. These socio-economic indicators were further reviewed by regional breakout groups for relevance in different regions of the world.

Process studies

The last GLOCHAMORE workshop focused on Process studies (Samedan, Switzerland, July 2005).

GLOCHAMORE and TEMS

GTOS participated in the final deliberations of GLOCHAMORE to ensure mutual reinforcement of overall aims, strengthening the TEMS Mountain Module and the conclusions in the GLOCHAMORE report. The final GLOCHAMORE research strategy contains proposals for environmental and social monitoring that should contribute to the Mountain Module of TEMS with respect to its use for global change. These monitoring recommendations will assist site managers to track the impacts of global change on their reserves – an important first step towards developing effective adaptation programmes.

Publication of the Research Strategy

The Open Science Conference (OSC) on Global Change in Mountain Regions (Perth, Scotland, UK, October 2005) was the final GLOCHAMORE activity. The conference synthesized the work of the previous two years and finalized the GLOCHAMORE Research Strategy, published in December 2005. The document is organized by themes, starting with drivers of global change, continuing with the impacts on ecosystems, their goods and services and on people's well-being, and closing with themes related to adaptation. The strategy provides researchers and managers with a planning and implementation guide for global change research.

Global Observation Research Initiative in Alpine Environments (GLORIA) - monitoring biodiversity Contact: Dr. Georg Grabherr, University of Vienna

MRI: http://mri.scnatweb.ch/
GLOCHAMORE strategy: http://mri.scnatweb.ch/content/view/74/31/.
Meetings: http://mri.scnatweb.ch/content/view/24/31/
GLORIA: www.gloria.ac.at

Mountains are the source of freshwater for half of humanity

Mountain Partnership

Importance of mountains

Mountains are complex and fragile ecosystems that cover almost a quarter of the earth's land surface and host 12 percent of its people. Mountain regions provide critical goods and services, not only for mountain inhabitants but also for lowland communities. They are storehouses of genetic diversity that help feed the world, as well as the source of freshwater for half of humanity. Yet, mountains are under threat from climate change, overexploitation and environmental degradation. Mountain people are among the world's poorest and hungriest: a disproportionate number of the world's 840 million chronically undernourished people live in mountain areas.

Photo: T.Hofer

Monitoring Climate Change

Due to their fragility and diversity, mountain ecosystems register global environmental changes earlier and more clearly than lowland systems. Consequently, this high sensitivity provides unique opportunities to detect, analyse and model global change processes and their effects on the socio-economic conditions and on livelihoods in mountain areas.

International Mountain Day

After the success of the International Year of Mountains in 2002, the UN General Assembly designated 11 December, from 2003 onwards, as 'International Mountain Day' to maintain awareness of mountain issues and to keep mountains on the global agenda. FAO, which served as the lead agency for International Year of Mountains, was mandated to lead the observance of International Mountain Day. The theme chosen for International Mountain Day in 2005 was: 'Sustainable Tourism for Poverty Alleviation in Mountain Areas'. Sustainable tourism strives to make a low impact on the environment and local culture, while helping to generate income and employment for local communities. The activities are directly related to the UN Millennium Development Goals (MDGs) of eradicating extreme hunger and poverty (#1), as well as the necessity of working together to protect our common environment (#7).

Mountain Partnership

Launched at the World Summit on Sustainable Development in 2002, the Mountain Partnership is a voluntary alliance of partners dedicated to improving the lives of mountain people and protecting mountain environments around the world. Currently members include: 47 countries, 14 intergovernmental organizations and 75 major groups (which includes NGOs and the private sector). The initiatives and activities of the Mountain Partnership are guided by the recommendations of the World Summit on Sustainable Development. They cover specific themes – including policy and law, sustainable livelihoods, watershed management, research, gender, education, and sustainable agriculture and rural development in mountains (SARD-M) – and different geographic areas, such as the Andes, Central America and the Caribbean, Central Asia, east Africa, Europe and the Hindu Kush Himalaya.

The Mountain Partnership is supported by a Secretariat, hosted by the Food and Agriculture Organization of the United Nations (FAO). The Secretariat acts as a central reference point for networking and liaison for the Mountain Partnership and collaborates closely with the Mountain Forum to deliver key information and communication services to all Partnership members.

Photo: T.Hofer

FAO and mountains

Apart from hosting the Mountain Partnership Secretariat, FAO has a strong emphasis on sustainable mountain development as part of its regular programme. This includes assisting countries (e.g. Armenia, Cuba, Kyrgyzstan, Democratic People's Republic of Korea, Poland, Tajikistan and West African countries) to tackle mountain issues through capacity building, institutional strengthening and pilot field activities. It also includes contributing to global processes such as the work programme on mountain biological diversity within the CBD, the mountain chapter within the Millennium Ecosystem Assessment, the Mountain Research Initiative, GLOCHAMORE, and, finally, it includes conceptual work, such as the recently completed global review of watershed management experiences, entitled "towards a new generation of watershed management programmes and projects".

Peak to Peak

"Peak to Peak" is a monthly newsletter with the latest news, activities and events related to the Mountain Partnership (see Web site for free registration).

TEMS Mountain Module

GTOS has been working closely with FAO's mountain programme as well as with the Mountain Partnership Secretariat as it considers mountain-related climate change research as a priority. GTOS has contributed to the GLOCHAMORE initiative and has developed the TEMS mountain module, which facilitates the access to mountain-relevant data and information from around the world. The Module includes networks and sites relevant to mountain issues and feature a list of primary indicators, data holders and maps with specific information on mountains. Importantly, the Module allows users to make queries on sites that are specific to mountain issues, and will link global environmental and socio-economic data for mountain ecosystems.

International Mountain Day:
www.fao.org/mnts/intl_mountain_day_en.asp
Mountain Partnership: www.mountainpartnership.org/
GTOS mountains: www.fao.org/gtos/gt-netMOU.html
TEMS Mountain Module: www.fao.org/gtos/tems/mod_mou.jsp

Wilfried Haeberli
and Roger Barry

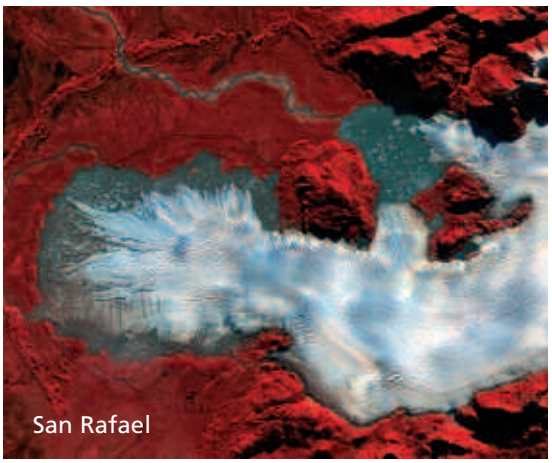
The global retreat of mountain glaciers during the 20th century is striking. Increasing mass losses since about 1980 indicate accelerated climatic forcing.

Global Terrestrial Network for Glaciers (GTN-G)

Mountain glaciers have been systematically observed for more than a century in various parts of the world. Glaciers and ice caps are, therefore, prime indicators in early-detection strategies in global climate-related observations. Although forming only about 0.7 percent of the global ice volume, they are of great importance regionally as water resources, and glacial melt contributes to the observed sea level rise.

Monitoring of glaciers

Advanced monitoring strategies developed by the World Glacier Monitoring Service (WGMS) for GTN-G within GTOS integrate detailed observations of mass balance and flow at selected reference glaciers for process understanding and numerical modelling, with more widely distributed determinations of changes in length, area and volume; repeated compilation of glacier inventories enables global coverage to be reached. In all, glaciers and ice caps are estimated to be about 160 000, covering an area of about 785 000 km^2. Basic information for about 44% (≈ 71 000) of these glaciers is currently stored in the World Glacier Inventory (WGI) and is available in digital form from a Web site at the National Snow and Ice Data Center (NSIDC), University of Colorado at Boulder (link below). Quantitative information was mainly obtained from aerial photographs or topographic maps from the 1970s and 1980s, of varying quality. Many areas are still missing, although preliminary overview data (mainly total area) has been compiled for these. For assessment of glacier changes over decades and globally, WGI provides the most comprehensive data set. In close cooperation with NSIDC and WGMS, the Global Land Ice Measurement from Space (GLIMS) project is compiling modern (circa 2000) data sets in a standardized format by analysis of multispectral Landsat TM/ETM+ and ASTER satellite scenes. Outlines for 51 000 glaciers are now available online.



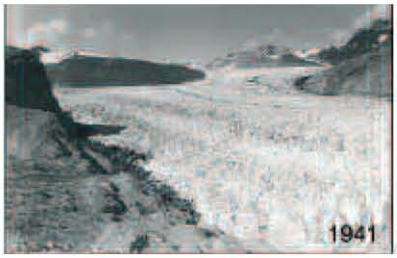
San Rafael

History of data collection

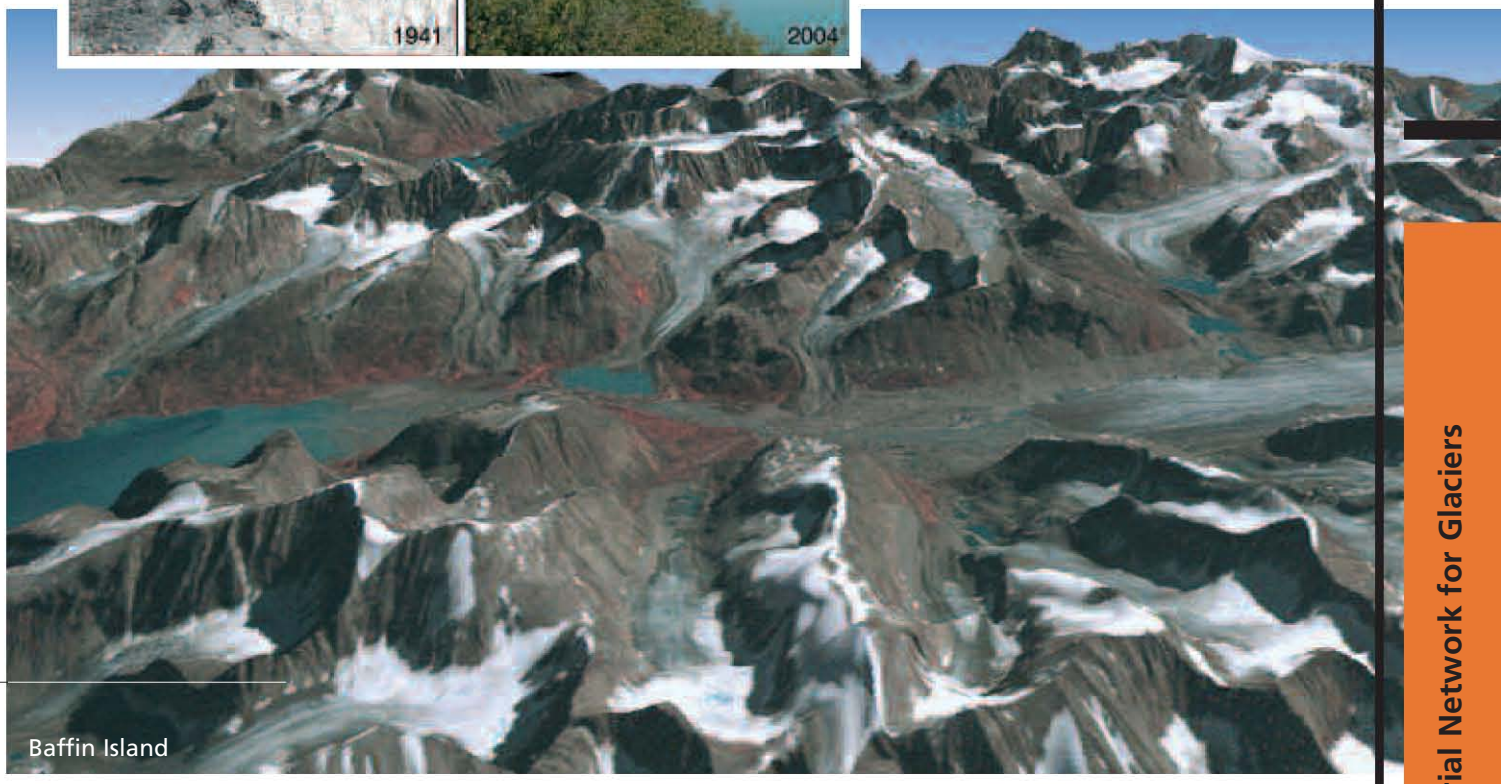
Worldwide collection of information about ongoing glacier change was initiated for about 50 Alpine glaciers in 1894, with the founding of the International Glacier Commission. In 1986, WGMS was established to maintain and continue data collection when two former services – the Permanent Service on Fluctuations of Glaciers (PSFG) and the Temporary Technical Secretariat for the World Glacier Inventory (TTS/WGI) – were combined. WGMS is based in Zurich, Switzerland, and collects standardized observations on changes in mass, length, area and volume of glaciers with time (glacier fluctuations). Close collaboration with the GLIMS project forms a basis for systematic integration of remote sensing data for future worldwide glacier observation.

Global glacier network

WGMS has managed the Global Terrestrial Network for Glaciers (GTN-G) since its creation in 1998. The GCOS Essential Climate Variables for glaciers and ice caps are mass balance and length/area. GTN-G prepares reports on annual mass balance for some 60 glaciers (most records beginning in the 1950s–1960s), and length changes for some 550 glaciers worldwide (accessible through its home page – see link). Satellite-based glacier inventories are compiled within the GLIMS-project.



William O. Field. 1941. Muir/Riggs glaciers. and Bruce F. Molnia. 2004. Muir/Riggs glaciers.
Both from the Online glacier photograph database. Boulder, CO: National Snow and Ice Data Center/World Data Center for Glaciology. Digital media.



Baffin Island

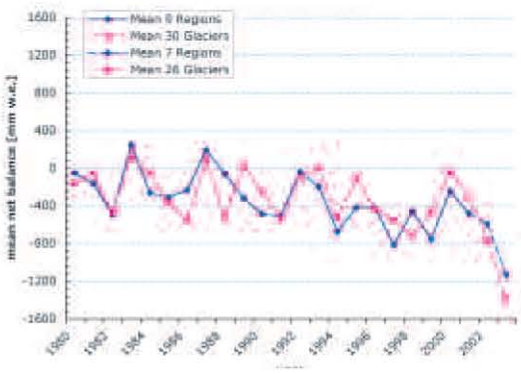
Rapid glacier loss

The *Fluctuations of Glaciers* report for 1995–2000 and the *Glacier Mass Balance Bulletin* for 2002–2003 (85 sites) are available and illustrate the acceleration of glacier melt in the last two decades. The implication is that many low-latitude mountain ranges may become deglaciated within a few decades, especially glaciers in tropical mountains, but also glaciers with a long series of mass-balance observations that now constitute the core of the observational network. Since 2000, ice loss in the European Alps has been around 15% (3% per year) of the total remaining volume.

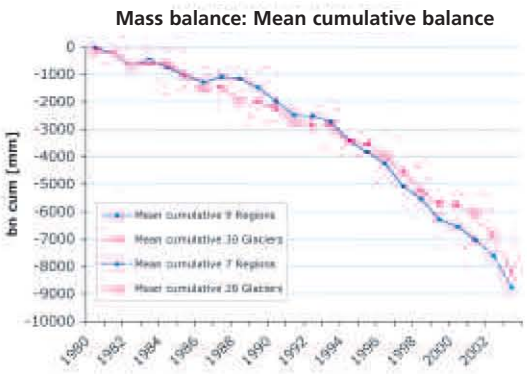
Recent activities

- Publication of a new glacier inventory for the Indian Himalaya, which is being digitized for incorporation in the WGMS database.
- Development of mass balance measurement projects in New Zealand and Patagonia.
- The presentation of photographic pairs for 14 Alaskan glaciers with century-long records (see link).

Mass balance: Mean net balance



Mass balance: Mean cumulative balance



Mass balance: Annual and cumulative mass balances (expressed as mean thickness loss in water equivalent) of glaciers from the WGMS/GTN-G network.
San Rafael: Glaciar San Rafael (Northern Patagoniana Icefield) as seen from the ASTER satellite sensor on 20 May 2000. The glacier now terminates in a pro-glacial lake which might accelerate its future retreat. The large moraine surrounding the lake is from the historical maximum extent of the glacier.
Baffin Island: Synthetic oblique perspective view towards the east showing several mountain and valley glaciers on Cumberland Peninsula (Baffin Island, CA). The corresponding ASTER image has been draped over the ASTER-derived DEM. Inventory work is in progress here as part of the GLIMS project. Image created by F. Paul, Zurich.

GLIMS: http://nsidc.org/data/glims
WGI: http://nsidc.org/data/glacier_inventory
WGMS: www.wgms.ch
Alaskan glaciers records:
http://nsidc.org/data/glacier_photo/special_collection.html

Jerry Brown
and Sharon L. Smith

Permafrost temperature reflects integrated changes in ground surface energy balance, in turn reflecting possible climate change

Global Terrestrial Network for Permafrost (GTN-P)

Permafrost refers to earth materials that remain at or below 0°C for at least two consecutive years. In the Northern Hemisphere, permafrost regions occupy approximately 23 million km^2, with permafrost underlying between 12 and 17 million km^2. These areas include large regions of Canada, China, Mongolia, Russia and Alaska, and with smaller permafrost areas at higher elevations in mountain chains of many other countries in both the Northern and Southern Hemispheres. The thickness of permafrost can exceed 600 m in the high latitudes. Southward, permafrost thins and becomes discontinuous. Unlike snow and ice covers, permafrost is not easily observed remotely, and requires *in situ* observations to define its extent and properties.

Monitoring of permafrost and active layer

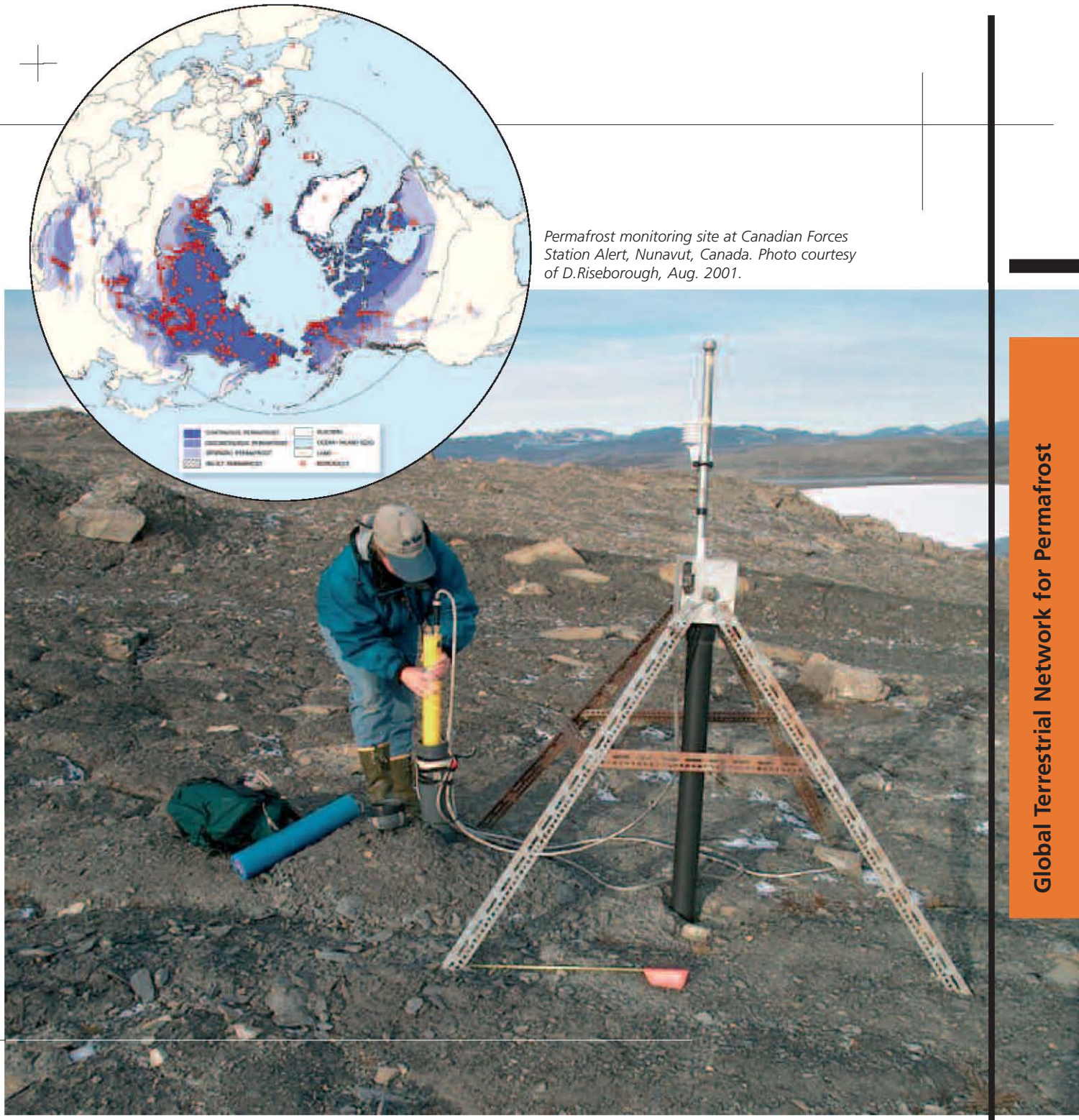
Permafrost monitoring is conducted mainly through ground-based, point measurements. Permafrost thermal state (i.e. ground temperature) and active layer thickness are the key permafrost variables identified for monitoring under the GCOS/GTOS programmes. The Global Terrestrial Network for Permafrost (GTN-P), approved in 1999 and coordinated by the International Permafrost Association (IPA), comprises two international monitoring networks: Thermal State of Permafrost (TSP) and Circumpolar Active Layer Monitoring (CALM). More than 15 countries participate in these networks.

Permafrost temperature data are essential for detecting the terrestrial climate signal in permafrost terrain. The temperature signal in permafrost provides an indication of integrated changes in the ground surface energy balance, that in turn may reflect changes in climate. Many permafrost temperature records are of short duration and discontinuous, but some sites have continuous time series 20 to 30 years long.

Network extent and plans

The majority of the monitoring sites are located in the high latitude and high altitude regions of the Northern Hemisphere. Existing and new sites in Antarctica and the subantarctic are being added. The GTN-P is largely composed of regional networks, including the Mackenzie region in Canada; an Alaskan transect and deep boreholes in northern Alaska; the Permafrost and Climate in Europe (PACE) programme of boreholes, largely in alpine permafrost; and regional networks in China, Russia and Mongolia.

Currently, 125 sites, in both hemispheres contribute to CALM, which has operated for the last decade. The more recently established TSP has identified over 550 boreholes that can potentially contribute to GTN-P. Metadata and site information are available for many of these candidate boreholes (see GTN-P Web site). Both TSP and CALM are included in the International Polar Year (IPY) programme Permafrost Observatory Project (#50). Permafrost temperature measurements at many sites are planned for 2007–2008 to obtain a "snapshot" as a contribution to the IPY.



Permafrost monitoring site at Canadian Forces Station Alert, Nunavut, Canada. Photo courtesy of D.Riseborough, Aug. 2001.

A long-term commitment, however, is required to establish a permanent network of permafrost observatories as part of GTN-P.

Data products and coordination

No international funding is available explicitly for data management, and so this has been done largely on a voluntary basis. Management and dissemination of active layer data for CALM is currently supported through a grant from the U.S. National Science Foundation. Data management for TSP is partially supported by the Geological Survey of Canada through its research programmes. Both CALM and TSP contribute soil temperature and moisture data to the Terrestrial Ecosystem Monitoring Sites (TEMS) database. Several IPY proposals are pending, and, if funded, will provide additional resources for producing a comprehensive retrospective and contemporary database on the state of permafrost. IPA coordinates GTN-P activities with other international programmes, including the World Climate Research Programme - (WCRP-CliC) and the Integrated Global Observing Straregy - Cryosphere (IGOS - Cryo).

GTNP: www.gtnp.org
CALM: www.udel.edu/geography/calm
IPA: www.geo.uio.no/IPA
FGDC: http://nsidc.org/fgdc

Wolfgang Grabs

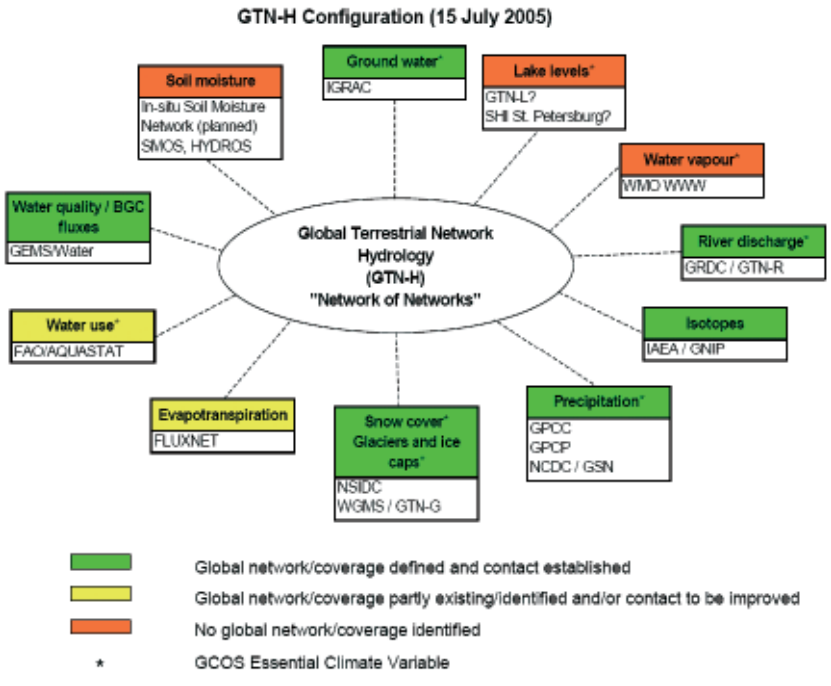
Globally integrated hydrological observations are the backbone for improved water management in the light of global change. GTN-H activities aim to enhance data accessibility and product development for a large variety of users.

Global Terrestrial Networks for Hydrology (GTN-H)

GTN-H partners

The Global Terrestrial Network for Hydrology (GTN-H) is the result of the joint efforts of the WMO Hydrology and Water Resources (HWR) Department, the Global Climate Observing System (GCOS) and the Global Terrestrial Observing System (GTOS). GTN-H comprises existing networks, global databases and global data product centres, and is based around a Coordination Group that includes:

- Global Runoff Data Centre – GRDC (BfG, Germany, under the auspices of WMO);
- Global Precipitation Climatology Centre – GPCC (DWD, Germany, under the auspices of WMO);
- Global Environmental Monitoring System – Water – GEMS/WATER (UNEP; Environment Canada); and
- Complex Systems Research Centre (University of New Hampshire, USA).



With the successive identification of participating partners, the core group is expanding.

GTN-H objectives and activities

Developing and improving the availability of hydrological data and information required to address global and regional climate, water resources and environmental issues is a prime objective of GTN-H. Benefits will include: improved weather and climate prediction; hydrological characterization to detect climate change; ability to predict the impacts of change; and an understanding of the global water cycle in an integrated context of weather, water and climate. Other benefits will be the improved assessment of freshwater availability and variability, and the greater understanding of large-scale hydrological processes.

Central to achieving these objectives is the development of global-scale data products. A major area of activity within GTN-H aims to develop and implement improved approaches and tools for data collection, access and management to support GTN-H objectives, and here GTN-H is a key partner in implementation of the Integrated Global Water Cycle Observation (IGWCO) theme of the IGOS partners.

Progress

GTN-H progress in the last biennium included:

- draft definition of hydrological metadata standards, based on the WMO core metadata standards (in collaboration with GRDC);
- a prototype online near-real-time river gauge stations data system;
- access to a first-guess global gridded precipitation product (courtesy of GPCC);
- online access to the global water quality database of GEMS/Water;
- second edition of the estimation of freshwater fluxes to the ocean (in collaboration with the University of New Hampshire and GRDC);

FAO/18609/G.Bizzarri

Ten selected hydrological variables relevant to climate change:

1. Surface water discharge
2. Surface water storage fluxes
3. Groundwater storage fluxes
4. Precipitation
5. Evapotranspiration
6. Relative humidity
7. Soil moisture
8. Snow water equivalent
9. Biogeochemical transport from land to ocean
10. Sediment load at large river mouths

FAO/11839/F.Mattioli

WMO hydrology medium-term priority areas:

- Monitor and assess variability of freshwater resources on seasonal and regional and subregional scales.
- Improve early warning and prediction skills, especially for floods and drought.
- Improve integrated hydrological observation systems by using satellite and *in situ* observations.
- Identify application-oriented tools required by hydrological services and water managers.
- Improve hydrological forecasting in ungauged basins.
- Build capacity by adapting scientific tools and methodologies for use in hydrological services and for decision-making by water managers.
- Address needs of water managers for climate information

- establishment of the GTN-H Web site and creation of an inventory of hydrological data and product sources (in collaboration with Environment Canada and the University of New Hampshire); and
- contribution to the Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC and the implementation plan of GEOSS.

Coordination meeting

The GTN-H Coordination Panel met in Koblenz, Germany (4–5 July 2005) to review key GTN-H projects; to identify additional networks; to develop products and plans relevant to global aspects of hydrology; and to address the need for improved availability and access to global hydrological data, information and products to support a wide range of climatic and hydrological objectives. The tasks and recommendations that emerged from the meeting included:

- linking to the Arctic and oceanographic communities regarding river runoff into oceans data;
- designate responsibility for the global harmonization of systematic observations of water vapour;
- endorse support to the planned NASA/ESA surface water interferometry mission(s);
- identify datasets (*in situ* and satellite) and research groups to be included in an international data centre for lakes and reservoirs;
- coordinate the development of standard observational practices for hydrological variables;
- ensure relevancy to GEOSS; and
- ensure collaboration and synergy with GTOS-TEMS, through the hydrology module.

The figure below shows the current development of GTN-H along the identification of key partners for the ten selected variables to be covered by GTN-H.

GTN-H home: http://gtn-h.unh.edu
GTOS networks home: www.fao.org/gtos/GT-NET.html
TEMS hydrology module:
www.fao.org/gtos/tems/mod_hyd.jsp

Thomas Maurer

harmonized real-time river discharge data capturing freshwater flux into oceans

Global Terrestrial Network for River Discharge (GTN-R)

Concept of GTN-R

The Global Terrestrial Network for River Discharge (GTN-R) is a recently launched project of the Global Runoff Data Centre (GRDC), aiming at improving access to near real-time river discharge data for selected gauging stations around the world, capturing the majority of the freshwater flux into oceans (Figure 1). GTN-R will draw together the already available heterogeneous information on near-real-time river discharge data provided by individual national hydrological services, and redistribute the data in a harmonized way. GTN-R is supported by an action item in the GCOS Implementation Plan, published in October 2004.

Beneficiaries

GTN-R will serve an increasing user community by supporting several activities, including the GCOS baseline river discharge network; GTN-H; future versions of the GRDC *Long Term Mean Annual Freshwater Surface Water Fluxes into the World Oceans* product; biogeochemical flux computations of the GEMS/Water Programme Office (UNEP/DEWA); the WHYMAP project; and an increasing number of activities and projects in the fields of climate and hydrological research and monitoring.

Network

GRDC has identified a priority network of around 380 river discharge reference stations and associated river basins. Feedback from local institutions will allow further refinement of this initial network. A metadata file of the network can be downloaded from the GTN-R Web site, as well as tables summarizing the acquisition progress. In addition, the Web site offers four visualizations of the network: images; interactive ESRI-ArcReader map

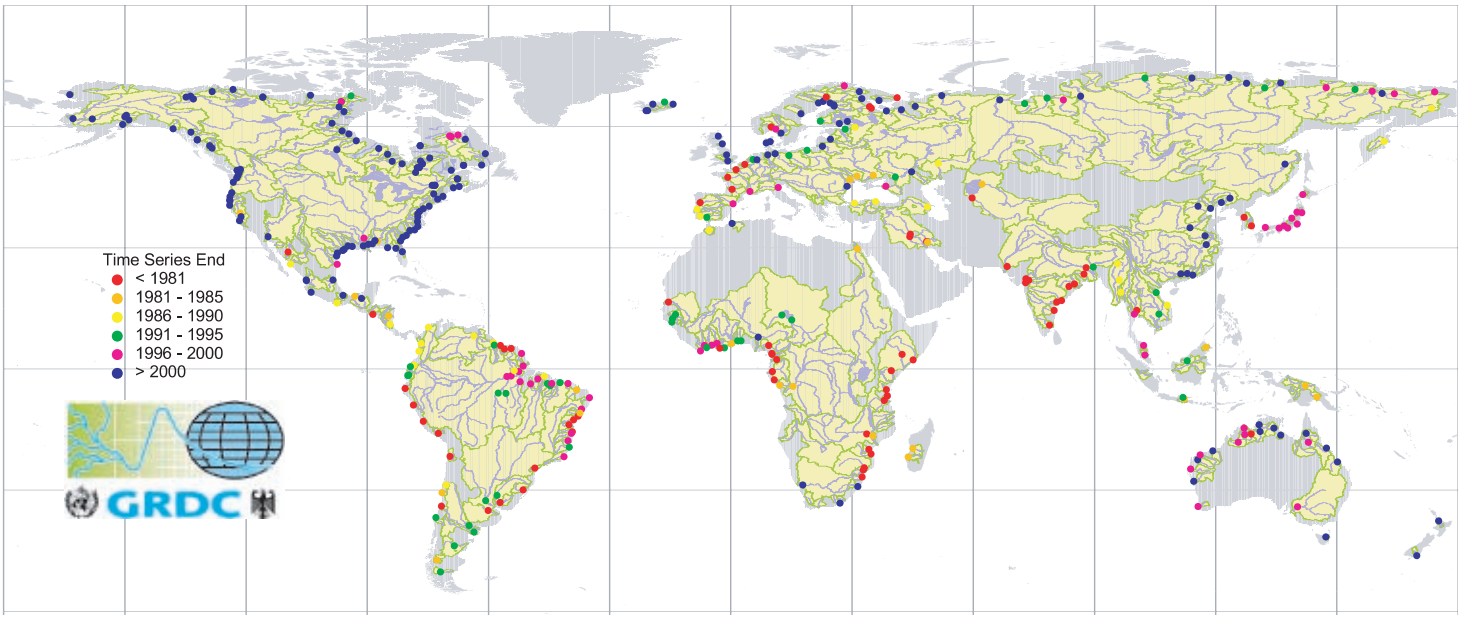


Figure 1. The Global Terrestrial Network for River Discharge (GTN-R). The 380 river discharge stations along continental coastlines cover 355 of the 391 basins depicted here (status as of 24 March 2005). The colour code indicates the latest data available in the GRDC database.

FAO/19563/G.Bizzarri

application; dataset for use with the 3D-visualization software WorldWind (NASA); and a map server based on Google-Maps.

Underlying software

The core of GTN-R is software (currently being developed at GRDC) that collects near-real-time discharge data from distributed servers via the internet, harmonizes and summarizes them, and makes them available again in a single, standard format through an FTP server. GRDC is also developing an application that will graphically display the collected and harmonized data in an interactively scaleable world map that can be accessed through the Web (similar to http://grdc.bafg.de/?9931). Absolute and relative current discharge values will be displayed as attributes.

Relation to ETN-R

GRDC has recently been contracted by the Joint Research Centre (JRC) of the European Commission to provide services very similar to GTN-R at the European scale, in support of the European Flood Alert System (EFAS), a JRC research project. Analogous to GTN-R, the associated project is called European Terrestrial Network for River Discharge (ETN-R). It significantly strengthens GRDC's capacity, as both projects require the same software tools and all developments will symbiotically be applicable for both European-scale and global-scale purposes. Moreover, ETN-R will foster data contribution to GTN-R from European countries.

Required cooperation

The success of GTN-R is critically dependent on the regular provision of near-real-time river discharge data from the reference stations. GRDC thus kindly requests the assistance of all organizations able to assist in providing access to available data. For further information, please see the corresponding sections on the GTN-R Web site.

GTN-R: http://gtn-r.bafg.de
ETN-R: http://etn-r.bafg.de
GRDC: http://grdc.bafg.de
GTOS networks: www.fao.org/gtos/GT-NET.html

David P. Turner
and Steve W. Running

Monitoring and validation of Global Net Primary Production

Operational products

A standard suite of global products characterizing vegetation cover, leaf area index (LAI), gross primary production (GPP) and net primary production (NPP) is now being produced operationally for the terrestrial biosphere, based on observations from the Moderate Resolution Imaging Spectroradiometer (MODIS) sensor. These data are intended for monitoring seasonal patterns, interannual variation and longer-term trends in biosphere behaviour. Early results show significant patterns in the interannual variation in regional and global NPP, related to large-scale climate events such as an El Niño year. Validation of these products is an essential step in establishing their utility; however, validation is challenging because of a variety of scaling issues – notably the mismatch in scale between the 1-km resolution of the MODIS products and the plot-scale measurements on the ground. Progress in validation of the MODIS products has been made in the recent biennium using several independent approaches.

BigFoot validation

The BigFoot Project was designed to address many of the critical scaling issues associated with validation, and has completed analysis of MODIS GPP and NPP at nine sites, representing a range of biomes (Figure 1). Differences between MODIS and BigFoot GPP and NPP products (Figure 2) are currently being investigated in terms of inputs to the MODIS NPP/GPP algorithm and values for internal parameters, such as vegetation light use efficiency. Simple direct comparisons of MODIS GPP with GPP estimated from eddy covariance flux towers have also been completed recently over a wider range of vegetation types (15 sites). These comparisons indicated that there was no consistent bias in the MODIS products relative to the measurements across all sites.

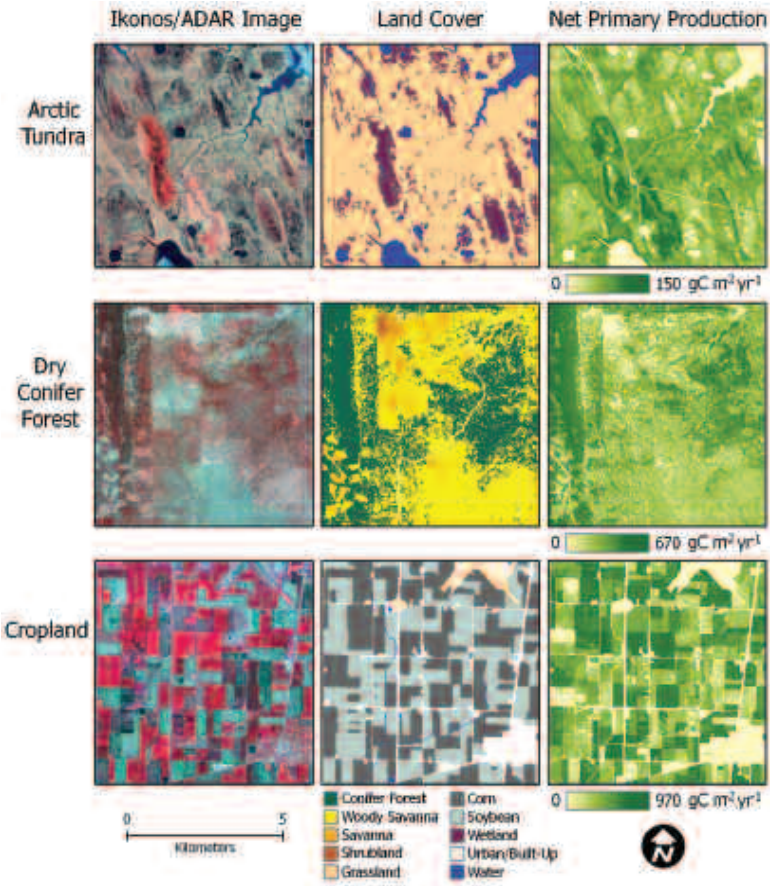


Figure 1. Preparation of NPP/GPP surfaces for use in comparisons with the MODIS NPP product. High resolution satellite remote sensing (Landsat ETM+, IKONOS, ADAR) is used to specify land cover and leaf area index for input to a spatially-distributed NPP model.

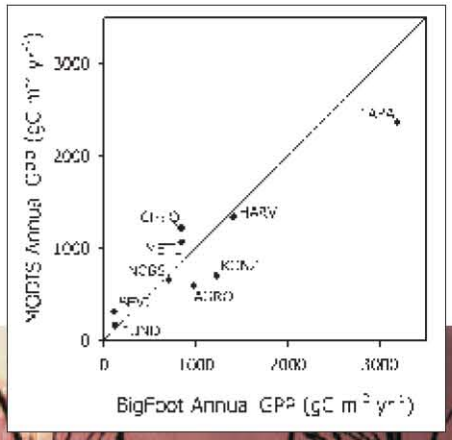


Figure 2. Comparison of Bigfoot and MODIS GPP estimates at nine sites. Values are means for 25 1-km² MODIS cells.

Network of validation sites and data products

The NPP/GPP validation studies completed thus far have set the stage for a global network of sites where GPP and NPP are measured on a regular basis together with the critical inputs to the MODIS NPP/GPP algorithm. In the case of flux tower sites, the measurement of daily canopy light use efficiency and the meteorological factors that regulate it could be used to further optimize parameters in the MODIS NPP/GPP algorithm. A significant impetus towards organizing a global set of sites for MODIS NPP/GPP validation has also been provided by the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC). The DAAC Web site provides a complete suite of MODIS products, including reflections, spectral vegetation indices, and NPP/GPP for 7 km x 7 km areas at 200 sites globally. The intent is that these data will be downloaded and used by site-level researchers in application and testing of NPP models.

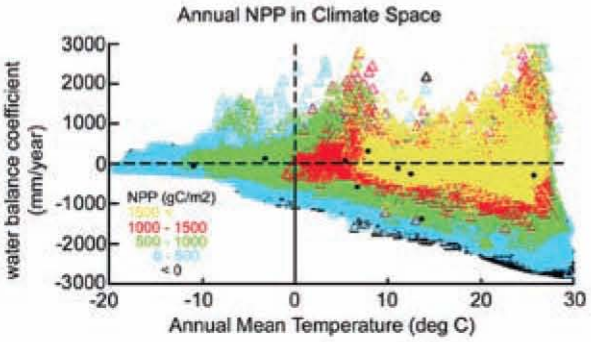


Figure 3. Location of the BigFoot sites (black circles) in climate space. Triangles are simulated NPP over a global grid.

Data usage

The regular monitoring of global NPP will help elucidate the continuing changes in the global carbon cycle, and the vulnerability of food and fibre production in particular regions to interannual variation in climate. The initial validation studies generally support the utility of the MODIS NPP product, but a stable network of sites sampling more fully the global biomes and climate space (Figure 3) is needed for comprehensive validation and refinement of the annual NPP estimates.

BigFoot: www.fsl.orst.edu/larse/bigfoot/index.html
ORNL DAAC: http://mercury.ornl.gov/ornldaac/. Search under "subsets".

Meetings

For information on upcoming meetings, workshops and conferences, please consult:

GTOS Web site: www.fao.org/gtos/meet.html

GOFC-GOLD Web site: www.fao.org/gtos/gofc-gold/2006_e.html

2006

Autumn	GLCN Central Asia regional workshop
8-16 July	30th Session of the World Heritage Committee, Vilnius, Lithuania
28-29 June	GTOS Panel Chairs meeting. Paris, France
26-27 June	TCO Panel meeting. Rome, Italy
28-29 March	9th TOPC Panel meeting. Ispra, Italy
21-25 March	GOFC-GOLD Symposium on Forest and Land Cover Observation. Jena, Germany
8-10 March	IGOL agriculture meeting. Rome, Italy
27 February - 1 March	3rd IGOL land theme development workshop. Beijing, China
22-24 February	NEESPI science meeting. Vienna, Austria
25-27 January	GTOS SC meeting, Rome, Italy
24 January	GTOS Panel Chairs meeting. Rome, Italy

2005

19-23 December	GLCN national workshop for India. Dehradun, India
17 December	12 bis IGOS-P meeting. London, UK
14-15 December	Second Plenary of GEO. Geneva, Switzerland
8-15 December	9th Ramsar CCP side event. Kampala, Uganda
5-9 December	GLCN Central America training workshop. San José, Costa Rica
1 December	GTOS side event at CBD SBSTTA-11, Montreal, Canada
28 November – 9 December	GTOS reporting at UNFCCC COP-11/SBSTA-23 Montreal, Canada
20 November	GTOS/GLCN at the CMS COP-8 Partnership Fair, Nairobi, Kenya
9 November	GTOS side event at Ramsar COP-9, Kampala, Uganda
3-4 November	IGOL Biodiversity meeting. Washington DC, United States of America
27-28 October	CEOS WGCV and GOFC-GOLD Global Vegetation Continuous Fields Validation Workshop. Brookings, South Dakota, United States of America
24 October	ICPC for GEO/GEOSS. Geneva, Switzerland
16-25 October	GTOS/GLCN at the CMS COP 8 Partnership Fair. Nairobi, Kenya
10-21 October	GLCN national workshop. Montevideo, Uruguay
13 October	Globcover PDR meeting. Frascati, Italy
28 September	TCO 2nd CarboAfrica meeting. Rome, Italy
20-21 July	2nd IGOL land theme development workshop. Reston, United States of America
10-17 July	29th Session of the World Heritage Committee, Durban, South Africa
4-5 July	Global Terrestrial Network – Hydrology. Koblenz, Germany

28 June	TCO 1st CarboAfrica meeting. Rome, Italy
20-24 June	GOFC-GOLD supports GEOSS through specification of land cover products. St. Petersburg, Russia
17-18 June	Northern Eurasia Regional Information Network (NERIN) Meeting. St. Petersburg, Russia
1 June	GLCN project SC meeting. Rome, Italy
26 May	IGOS-Partners 11bis Meeting. Geneva, Switzerland
25 May	9th G3OS meeting. Geneva, Switzerland.
5 May	GTOS/GLCN side event at UNCCD CRIC-3, Bonn, Germany
25-29 April	GLCN National workshop for China. Beijing, China
19-22 April	GOFC-GOLD Third Science and Technical Board Meeting. Beijing, China
12-13 April	GTOS Sponsors meeting. Rome, Italy
19-23 March	GLCN Middle East training workshop. Sharm El Sheikh, Egypt
14-16 March	Special Session on Global Observation of Urban Areas. Tempe, Arizona, United States of America
14 March	Development of a wildland fire accord. FAO Ministerial Meeting. Rome, Italy
15-18 February	GLCN National workshop for India. New Delhi, India
7-9 February	GOFC-GOLD Fire Implementation Team Meeting. Montreal, Canada
2-5 February	International Conference on Land-Cover and Land-Use Processes in the NEAR Region. Harbin, China

2004

8-9 December	LCCS training workshop. Pretoria, South Africa
29-30 November	GOFC-GOLD South America Network (REDLATIF) Regional Fire Meeting. Santiago, Chile
18 November	IGOS-Partners 11bis Meeting. Beijing, China
17 November	GOFC-GOLD Satellite-based fire monitoring network in Northern Eurasia workshop. Moscow, Russia
15-19 November	GLCN regional workshop for South America. Quito, Ecuador
18-22 October	Burnt Area Validation Meeting. Freemantle, Australia
7-8 October	GTOS Sponsors meeting. Rome, Italy
21-23 September	Land cover mapping and change assessment workshop. Florence, Italy
13-15 September	IGOS 1st land theme development workshop. Rome, Italy
9-13 August	5th Meeting of Southern Africa Fire Network (SAFNET). Mangochi, Malawi
26 July	Workshop on Ground-based Accuracy Assessments for Fire Occurrence and Deforestation Events. Brasilia, Brazil
14-16 July	GOFC-GOLD/FAO Workshop on Harmonization of Global Land Cover Products. Rome, Italy
22-25 June	Harmonization of terrestrial carbon measurements in CEE. Prague, Czech Republic
17-18 June	NORTH proposal for EU 6th framework workshop. Berlin, Germany
25 May	GTOS mini-preparation meeting. Rome, Italy
26 May	9th G3OS meeting. Rome, Italy
27 May	11th IGOS-P meeting. Rome, Italy
17-19 May	Southeast Asia Burnt Area Mapping Workshop. Kebangsaan, Malaysia
28-29 April	GTOS Coastal Implementation Workshop. Rome, Italy
6-7 April	TOPC Panel 8th session. Ispra, Italy
23-25 March	GOFC/GOLD Fire and CEOS LVP workshop on Global Geostationary Fire Monitoring Applications. Darmstadt, Germany
2-4 March	GOFC-GOLD Land Cover Implementation Team Meeting. Jena, Germany
23-26 February	GOFC-GOLD Northern Eurasia Regional Workshop. St.Petersburg, Russia
2-5 February	CEOS Land Cover Validation Workshop. Boston, Massachusetts, United States of America

Publications

All publications are available on request from the GTOS Secretariat, or can be downloaded from the GTOS Web site: **www.fao.org/gtos/pubs.html.**

In addition, the GOFC-GOLD publication series can be viewed at: **www.fao.org/gtos/gofc-gold/documents.html**

GTOS 40 GTOS Biennial report 2004–2005

GTOS 39 Report of the 3rd Meeting of the GOFC-GOLD Science and Technology Board. Beijing, China, 19–22 April 2005. Also published as GOFC-GOLD 21.

GTOS 38 GTOS Sponsors Meeting. Rome, Italy, 12–13 April 2005

GTOS 37 Report of the 2nd Meeting of the GTN-H Coordination Panel. Koblenz, Germany, 4–5 July 2005

GTOS 36 Coastal GTOS Strategic design and phase one implementation plan

GTOS 35 GTOS/GCOS 8th session of the Terrestrial Observation Panel for Climate. Summary Report. Also published as GCOS 93.

GTOS 34 GTOS Biennial report 2002–2003

GTOS 33 GTN-H Coordination Panel Meeting report. Toronto, Canada, 21–22 November 2002. Also published as GCOS 85.

GTOS 32 HWRP/GCOS/GTOS Expert Meeting on Hydrological Data for Global Studies report. Toronto, Canada, 18–20 November 2002. Also published as GCOS 84.

GTOS 31 TCO: The Frascati report on *in situ* carbon data and information. November 2002.

GTOS 30 GTOS Biennial report 2000–2001

GTOS 29 GCOS/GTOS/HWRP Expert Meeting on the Implementation of a Global Terrestrial Network – Hydrology (GTN-H). Koblenz, Germany, June 2001. Also published as GCOS 71

GTOS 28 Global Change and Mountain Regions. IGBP Mountain Research Initiative and IHDP. Also published as IGBP 49.

GTOS 27 Terrestrial Data Management and Accessibility Workshop in Central and Eastern Europe. Vàcràtòt, Hungary. 30 October–4 November 2000

GTOS 26 GCOS/GTOS/HWRP Establishment of a Global Hydrological Observation Network for Climate. Geisenheim, Germany, 26–30 June 2000

GTOS 25 IGOS-P Carbon Cycle Observation Theme: Terrestrial and Atmospheric Components. October 2000 (revised February 2001)

GTOS 24 GTOS Biennial report 1998–1999

GTOS 23 Terrestrial Carbon Observation Synthesis Workshop. Ottawa, Canada, 8–11 February 2000

GTOS 22 GTOS/GCOS Terrestrial Observation Panel for Climate, 5th session. Birmingham, UK, 27–30 July 1999

GTOS 21 GTOS Regional Implementation Plan for Southern Africa. February 2001

GTOS 20 Regional Implementation Plan for Central and Eastern Europe (CEE). February 2000

GTOS 19 GTOS Steering Committee, 2nd session. Santander, Spain, 15–19 June 1998

GTOS 18 GTOS Data and Information Management Plan. October 1998

GTOS 17 GTOS Implementation Plan. December 1998

GTOS 16 Report of the G3OS Joint Data and Information Management Panel, 4th session. Honolulu, United States of America, 28 May–1 April 1998

GTOS 15 GTOS/GCOS Terrestrial Observation Panel for Climate, 4th session. Corvallis, United States of America, 26–29 May 1998

GTOS 14 GTOS Annual Report 1997. December 1997

GTOS 13 GHOST – Global Hierarchical Observing Strategy. June 1997

GTOS 12 GCOS/GTOS Plan for Terrestrial Climate-related Observations, version 2.0. June 1997

GTOS 11 GCOS/GOOS/GTOS Joint Data and Information Management Panel (JDIMP), 3rd session. Tokyo, Japan, 15–18 July 1997

GTOS 10 Meeting of Experts on Ecological Networks. Guernica, Spain, 17–20 June 1997

GTOS 9 Global Observing Systems Space Panel (GOSSP), 3rd session. Paris, France, 27–30 May 1997

GTOS 8 GTOS Coordination and Implementation meeting. Rome, Italy, 12–15 May 1997

GTOS 7 GTOS and the Conventions. October 1996 (Updated April 1997)

GTOS 6 First meeting of the GTOS Steering Committee, final session. Rome, Italy, 2–5 December 1996

GTOS 5 Global Observing Systems Space Panel, 2nd session. Geneva, Switzerland, 16–18 October 1996

GTOS 4 *In Situ* Observations for the Global Observing Systems. Geneva, Switzerland, 10–13 September 1996

GTOS 3 Planning Group Report GTOS: Turning a sound concept into a practical reality. June 1996

GTOS 2 Expert Meeting on Hydrological Data for Global Observing Systems. Geneva, Switzerland, 29 April–1 May 1996

GTOS 1 GCOS/GTOS Terrestrial Observation Panel for Climate, 3rd session. Cape Town, South Africa, 19–22 March 1996

Acronyms

Acronyms – unfortunately in Earth observations you can't avoid them so we have provided a summary list of those used in this document.

ADAR	Airborne Data Acquisition and Registration
AQUASTAT	Information System on Water and Agriculture (FAO)
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
ATSR/AATSR	Along Track Scanning Radiometer/Advanced ATSR
AVHRR	Advanced Very High Resolution Radiometer
B-GTOS	Biodiversity GTOS Initiative
CALM	Circumpolar Active Layer Monitoring
CBD	Convention on Biological Diversity
CEOS	Committee for Earth Observation Satellites
C-GTOS	Global Terrestrial Observing System Coastal Panel
CH_4	methane
CITES	Convention on International Trade in Endangered Species of Wild Flora and Fauna
CMS	Convention on Migratory Species of Wild Animals
CO_2	Carbon dioxide
COP	Conference of the Parties
DAAC	Distributed Active Archive Center
DEM	Digital Elevation Model
EFAS	European Flood Alert System
EOS	Earth Observation Summit
ESA	European Space Agency
ESRI	Environmental Systems Research Institute
ETH Zürich	Swiss Federal Institute of Technology Zurich
ETM+	Enhanced Thematic Mapper (Landsat)
ETN-R	European Terrestrial Network for River Discharge
FAO	Food and Agriculture Organization of the United Nations
FAPAR	fraction of absorbed photosynthetically active radiation
FLUXNET	Flux and Energy Exchange Network
FTP	file transfer protocol
G3OS	Sponsors Group for the Global Observing Systems
GCMD	NASA Global Change Master Directory
GCOS	Global Climate Observing System
GCOS Cryo	Global Climate Observing System Cryosphere Theme
GCOS IP	Implementation Plan for the Global Climate Observing System
GCP	Global Carbon Project
GEO	Group on Earth Observations
GEMS	Global Environmental Monitoring System
GEMS/WATER	Global Environmental Monitoring System – Water
GEOSS	Global Earth Observation System of Systems
GHG	greenhouse gas
GHOST	Global Hierarchical Observing Strategy
GIS	geographical information system
GLCN	Global Land Cover Network
GLIMS	Global Land Ice Measurement from Space
GLOCHAMORE	Global Change in Mountain Regions
GLORIA	Global Observation Research Initiative in Alpine Environments
GNIP	Global Network of Isotopes in Precipitation
GOFC-GOLD	Panel on Global Observation of Forest and Land Cover Dynamics
GOSIC	Global Observing Systems Information Center
GPCC	Global Precipitation Climatology Centre
GPCP	Global Precipitation Climatology Project
GPP	gross primary production
GRDC	Global Runoff Data Centre

GSN	GCOS Surface Network
GTN-G	Global Terrestrial Network for Glaciers
GTN-H	Global Terrestrial Network for Hydrology
GTN-L	Global Terrestrial Network for Lakes
GTN-P	Global Terrestrial Network for Permafrost
GTN-R	Global Terrestrial Network for River Discharge
GTOS	Global Terrestrial Observing System
HWR	WMO Hydrology and Water Resources Department
HYDROS	Hydrosphere State Mission (NASA HYDROS satellite, to be launched in 2010)
IAEA	International Atomic Energy Agency
IAO	Istituto Agronomico per l'Oltremare (Italy)
ICPC	Inter-Agency Coodination and Planning Committee
IGBP	International Geosphere-Biosphere Programme
IGCO	Integrated Global Carbon Observation
IGOL	Integrated Global Observations for Land
IGOS	Integrated Global Observing Strategy
IGRAC	International Groundwater Resources Assessment Centre
IGWCO	Integrated Global Water Cycle Observation
IHDP	International Human Dimensions Programme on Global Environmental Change
IKONOS	earth imaging satellite (company: Space Imaging)
IPA	International Permafrost Association
IPY	International Polar Year
JRC	Joint Research Centre
Landsat ETM+	Landsat Enhanced Thematic Mapper
LC	Land Cover
LCCS	Land Cover Classification System
LU/LC	Land Use/Land Cover
LUCC	land use and land cover change
MAB	Man and the Biosphere Programme (UNESCO)
MBR	Mountain Biosphere Reserve
MDG	Millennium Development Goals
MODIS	Moderate Resolution Imaging Spectroradiometer
MRI	Mountain Research Initiative
MSS	Multi-Spectral Sensor (Landsat)
NASA	National Aeronautics and Space Administration, United States of America
NCDC	National Climatic Data Center
NFPI	National Focal Point Institutions
NPP	net primary production
NSIDC	National Snow and Ice Data Center, United States of America
ORNL	Oak Ridge National Laboratory, United States of America
OSC	Open Science Conference
PSFG	Permanent Service on Fluctuations of Glaciers
SARD-M	Sustainable Agriculture and Rural Development in Mountains
SBSTTA	Subsidiary Body on Scientific, Technical and Technological Advice (CBD)
SDI	Spatial data infrastructure
SHI	State Hydrological Institute (Russian Federation)
SMOS	Soil Moisture and Ocean Salinity Mission
SNSF	Swiss National Science Foundation
SPOT	Système Probatoire d'Observation Terrestre (France)
TCO	Terrestrial Carbon Observation
TEMS	Terrestrial Ecosystem Monitoring Sites
TM	Thematic Mapper [Landsat]
TOPC	Terrestrial Observing Panel for Climate
TSP	Thermal State of Permafrost
TTS/WGI	Temporary Technical Secretariat for the World Glacier Inventory
UNCCD	UN Convention to Combat Desertification
UNEP	United Nations Environment Programme
UNEP/DEWA	GEMS/Water Programme Office
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	UN Framework Convention on Climate Change
USAID	United States Agency for International Development
USGS	United States Geological Survey
VGT	SPOT-4 vegetation instrument (France)
WCRP-CliC	World Climate Research Programme - Climate and Cryosphere project
WDD	World Deltas Database
WDN	World Deltas Network
WGCV	Working Group for Calibration and Validation
WGI	World Glacier Inventory
WGMS	World Glacier Monitoring Service
WHC	World Heritage Convention
WHYMAP	World-wide Hydrogeological Mapping and Assessment Programme
WMO	World Meteorological Organization
WSSD	World Summit on Sustainable Development
WWW	World Weather Watch (WMO)

Donors and financial support

During the last biennium, the activities of GTOS Secretariat and its Panels have been supported by the following institutions:

Canadian Space Agency – www.space.gc.ca/asc/eng/default.asp

Center for Global Change and Earth Observations, Michigan State University, United States of America – www.globalchange.msu.edu

Committee on Earth Observation Satellites, Land Product Validation Subgroup of the Working Group on Calibration and Validation – http://lpvs.gsfc.nasa.gov

European Commission Joint Research Centre (JRC) – www.jrc.cec.eu.int

European Space Agency (ESA) – www.esa.int

Food and Agriculture Organization of the United Nations (FAO) – www.fao.org

Friedrich-Schiller University, Jena, Germany – www.uni-jena.de

Global Fire Monitoring Center (GFMC) – www.fire.uni-freiburg.de

Government of Italy – Italian Development Cooperation – www.esteri.it/ita/2_10_128.asp

Government of the Czech Republic – www.mfa.cz

International Strategy for Disaster Reduction (ISDR) – www.unisdr.org

National Aeronautics and Space Administration (NASA), United States of America
www.nasa.gov/home

National Oceanic and Atmospheric Administration (NOAA), United States of America – www.noaa.gov/about-noaa.html

National Remote Sensing Center of China (NRSCC), Chinese Ministry of Science and Technology (MOST) – www.nrscc.gov.cn

Natural Resources Canada, Canadian Forest Service – www.nrcan.gc.ca/cfs-scf/index_e.html

SysTem for Analysis, Research and Training (START) – www.start.org

University of Maryland, United States of America – www.umd.edu

University of Tuscia, Italy – www.unitus.it, http://gaia.agraria.unitus.it/

United Nations Environment Programme (UNEP) – www.unep.org

United States Geological Survey (USGS) – www.usgs.gov

United States Agency for International Development (USAID) – www.usaid.gov

World Meteorological Organization (WMO) – www.wmo.ch

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www.fao.org/gtos

GTOS Donor

Cooperazione Italiana
(www.esteri.it/eng/2_10_128.asp)

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FAO – Food and Agriculture Organization of the United Nations (www.fao.org)

ICSU – International Council for Science (www.icsu.org)

UNEP – United Nations Environment Programme (www.unep.org)

UNESCO – United Nations Educational, Scientific and Cultural Organization (www.unesco.org)

WMO – World Meteorological Organization (www.wmo.ch)

The Global Terrestrial Observing System

The Global Terrestrial Observing System (GTOS) was established in January 1996 by its five co-sponsoring organizations in response to international calls for a deeper understanding of global change in the Earth System.

The central mission of GTOS is to provide policy-makers, resource managers and researchers with access to the data they need to detect, quantify, locate, understand and warn of change (especially reduction) in the capacity of terrestrial ecosystems to support sustainable development. Since its establishment, GTOS has been working to improve the quality, the coverage and accessibility of terrestrial ecosystem data.

GTOS is developing activities that focus on five issues of global concern:

1. Change in land quality.
2. Availability of freshwater resources.
3. Loss of biodiversity.
4. Climate change.
5. Pollution and toxicity.

GTOS promotes: integration of biophysical and socio-economic georeferenced data; interaction between monitoring networks, research programmes and policy-makers; data exchange and application; quality assurance and harmonization of measurement methods; and collaboration to develop regional and global datasets.

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